Annals
of the
Missouri Botanical Garden

Volume XX
1933

With Twenty-three Plates and Forty-three Figures

Published quarterly at 8 West King Street, Lancaster, Pa., by the Board of Trustees of the Missouri Botanical Garden, St. Louis, Mo

Entered as second-class matter at the post-office at Lancaster, Pennsylvania, under the Act of March 3, 1879

Annals

of the

Missouri Botanical Garden

A Quarterly Journal containing Scientific Contributions from the Missouri Botanical Garden and the Graduate Laboratory of the Henry Shaw School of Botany of Washington University in affiliation with the Missouri Botanical Garden.

Information

The Annals of the Missouri Botanical Garden appears four times during the calendar year: February, April, September, and November. Four numbers constitute a volume.

Subscription Price - - - $6.00 per volume
Single Numbers - - - - 1.50 each

Contents of previous issues of the Annals of the Missouri Botanical Garden are listed in the Agricultural Index, published by the H. W. Wilson Co.

TABLE OF CONTENTS

Annals
of the
Missouri Botanical Garden

VOL. 20 FEBRUARY, 1933 No. 1

A NEW YELLOW NYMPHAEA FROM TROPICAL AFRICA[1]

GEORGE H. PRING
Superintendent, Missouri Botanical Garden

ROBERT E. WOODSON, Jr.
Research Assistant, Missouri Botanical Garden
Instructor in Botany, Henry Shaw School of Botany of Washington University

Nymphaea (§ Brachyceras) Burttii Pring & Woodson, spec. nov., foliis magnis longe-petiolatis orbiculare-sagittatis margine plus minusve conspicue undulato-sinuatis apice late obtusis vel rotundatis sinu profundo auriculis leviter divergentibus obtusis 25–35 cm. longis subcoriaceis utrinque viridibus vel saepius purpureo-maculatis glaberrimis vel umbilico paulo papillato subtus nervis manifestis sed vix prominentibus; floribus speciosissimis primulino-flavis 15–18 cm. diametro metientibus, sepalis ovato-lanceolatis acutiusculis 5–8 cm. longis 2–3 cm. latis dilute viridibus immaculatis laevibus, petalis ca. 20–23 anguste ellipticis apice acuminatis vel anguste acutis medio versus gradatim angustatis plerisque 5-nervatis exterioribus quam sepalis paulo brevioribus ca. 4.5–7.0 cm. longis 1.0–2.5 cm. latis, staminibus 190–200 linearibus connectivo manifeste elongato basi paulo ampliato exterioribus ca. 5 cm. longis dilute cadmio-flavis, carpellis 28–30 stylo linearo profunde inclinato stigmate concavo; fructu minore 3.5–4.0 cm. diametro metiente, seminibus ovoideo-oblongoideis apice minutissime apiculatis longitudine leviter puncticulato-striatis griseo-brunneis maximo ca. 0.075 cm. minimo ca. 0.05 cm. diametro metientibus.—Cult. Missouri Botanical Garden, Aug., 1930, *G. H. Pring s. n.* (Herb. Mo. Bot. Garden, TYPE).

Leaves large, long-petiolate, orbicular-sagittate, margin more or less conspicuously undulate-sinuate, apex broadly obtuse or rotund, sinus relatively deep and narrow, auricles obtuse, slightly

[1] Issued April 29, 1933.

divergent, 25–35 cm. long, subcoriaceous, either surface green, or occasionally somewhat purplish-maculate, particularly when young, glabrous, or the umbilicus slightly papillate, the nerves manifest but not prominent beneath; flowers showy, primrose-yellow, very fragrant, 15–18 cm. in diameter; sepals ovate-lanceolate, acute, 5–8 cm. long, 2–3 cm. broad, pale green, without purple spots, smooth; petals about 20–23, narrowly elliptic, apex

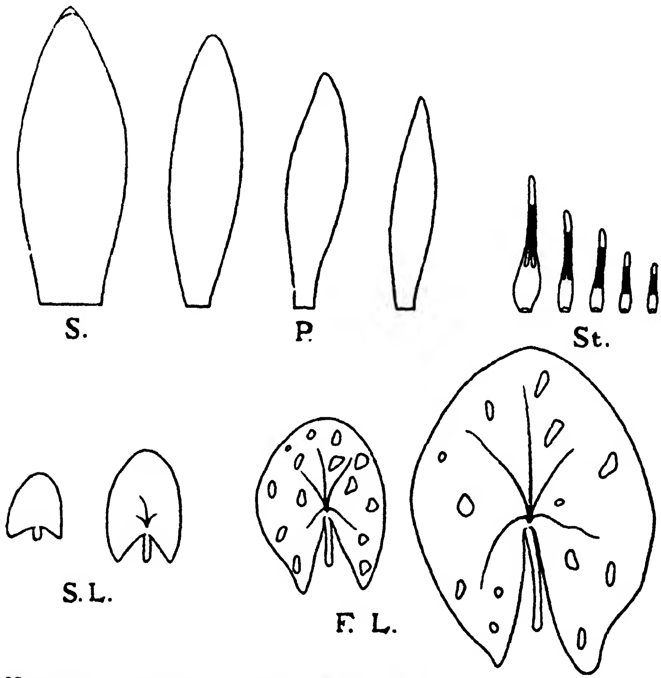


Fig. 1. *Nymphaea Burttii* Pring & Woodson: *S.*, sepals; *P.*, petals; *St.*, stamens; *S.L.*, submerged leaves; *F. L.*, floating leaves.

acuminate to narrowly acute, the base gradually narrowed from about the middle, 5-nerved, the exterior somewhat shorter than the sepals, usually 4.5–7.0 cm. long, 1.0–2.5 cm. broad; stamens 190–200, linear, the exterior about 5 cm. long, cadmium-yellow, the connective manifestly elongate, somewhat broadened at the base; carpels 28–30, the style linear, sharply inclined, the stigma concave; fruit relatively small, about 3.5–4.0 cm. in diameter; seeds ovoid-oblongoid, minutely apiculate, rather inconspicuously

puncticulate-striate longitudinally, about 0.075 cm. long, 0.05 cm. broad, grayish-brown.—Cultivated at the Missouri Botanical Garden, Aug., 1930, *G. H. Pring s. n.* (Herb. Mo. Bot. Garden, TYPE).

Only two yellow tropical Nymphaeas have previously been described from Africa: *N. sulphurea* Gilg and *N. Stuhlmannii* Schwfth. & Gilg. The former differs from *N. Burttii* chiefly in the smaller flowers (4–7 cm. in diam.) and leaves (4.5–5.5 cm. long), which are almost exactly orbicular-cordate in outline, purplish-maculate sepals, and more elongate tubers. *N. Stuhlmannii* is easily distinguishable from *N. Burttii* by the somewhat smaller flowers (10–15 cm. in diam.), with broader, obovate, obtuse or rounded petals, and smaller (21–25 cm. long), entire leaves, which are broadly ovate-cordate in outline, with broad, rounded, regular lobes. Furthermore, the venation of the leaves of *N. Stuhlmannii* is extremely verrucose beneath. The type specimen of *N. Stuhlmannii* has not been available to the writers for personal examination, but has been compared with a duplicate specimen of *N. Burttii* by Dr. H. Melchior, of the Botanical Museum at Berlin-Dahlem, who kindly affirmed the distinction of either species. A photograph of the type specimen of *N. Stuhlmannii* (*Stuhlmann 410* in Hb. Berol.), generously provided by Dr. L. Diels, Director of the Botanical Garden and Museum at Berlin-Dahlem, has been deposited in the herbarium of the Missouri Botanical Garden.

After a search of over ten years, the director of the Missouri Botanical Garden obtained in September, 1929, a seed-pod of what was presumed to be *Nymphaea Stuhlmannii* through the personal efforts of Mr. B. D. Burtt, Esq., botanist for the Tsetse Research Bureau, Kondoa, Tanganyika Territory. An excerpt from Mr. Burtt's notes is quoted.

> "The seed was collected from plants growing in a seasonal rain-pond in the Sambala 'Mbuga' seasonal swamp, the plants having spectacular yellow flowers 8 inches in diameter and sweet scented. The flowers float on the surface of the water and on examination were found to contain dead bees (*Apis melifera* [?]) that were imprisoned by the anthers over the stigmatic surface of the flowers. The plants were collected on May 19, 1929, the seed from the same locality on July 15, 1929. Other plants were collected March 16, 1929, from a seasonal rain pond near Salia, Kondoa Distr. I have observed the plant in seasonal rain ponds at Magungila, Wembare Steppe in 1928, also near Lilbilin, Massai Land, in 1927."

The single, small seed-pod, in somewhat immature condition, was received at the Garden on September 19, 1929. It was immediately cleaned, and the many seeds planted in the greenhouse water-lily tanks. Three weeks later a single seed germinated from the lot, producing its first primrose-yellow flower on June 17, 1930. On July 30, the plant was removed from its pot and planted in the pond out of doors where it continued to bloom until frost.

The successful introduction of a yellow tropical water-lily has opened an entirely new field for the hybridist. For many years the available colors in the Brachyceras group have been limited to blue and pink, and more recently to white through the introduction from the Missouri Botanical Garden of the hybrid "Mrs. G. H. Pring." During the past three seasons 250 pollinations have been made with the pollen of *N. Burttii*, resulting in many variable forms of commercial interest. The first season (1930) was devoted to selfing the yellow-flowered species, and many fertile seed-pods resulted. The following year twenty specimens were grown from seed and planted in the ponds out of doors. No variation in the color of the flowers was observed, but a variable character was evident in the peduncle and petioles, some being pure green, while about an equal number were brownish.

An unusual character, which appears to be dominant in all the plants, is a peculiar twisting of the peduncle, the day before the flower opens, in such a manner as to submerge the bud. The following morning, however, the peduncle straightens, holding the open flower erect in a natural position. This action has also been observed in several hybrids.

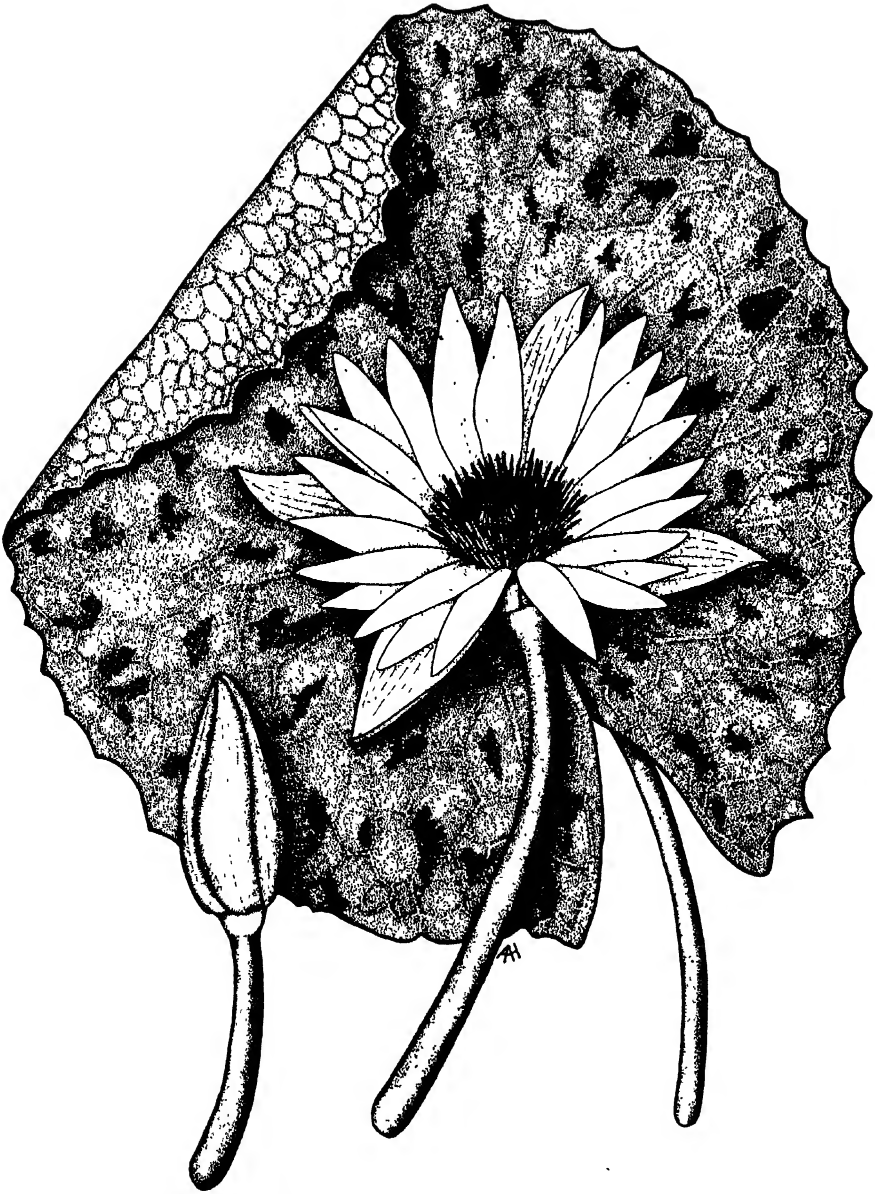
As a propagator, *Nymphaea Burttii* is by far the poorest of any grown at the Garden. Of the fifty propagating tubers secured from pot plants during the past two seasons, only one has produced growth up to the present, despite the fact that they have been in the heated propagating tanks for a period of six months. Since it is an extremely poor propagator from tubers and extreme heat is necessary for growth, it is very doubtful if it will find a place in garden pools. On the other hand, the hybrids derived from it, particularly the "Saint Louis," are both readily propagated from tubers and suitable for cooler water.

Explanation of Plate

PLATE 1

Leaf, bud, and flower of *Nymphaea Burttii* Pring & Woodson, × ⅜.

del. A. A. Heinze



PRING & WOODSON—A NEW YELLOW NYMPHAEA

CONTRIBUTION TO THE LICHEN FLORA OF NORTH AMERICA[1]

VELI J. P. B. RÄSÄNEN

Instructor in the Agricultural School, Kurkijoki, Finnland

The lichens here described have been collected in the northern section of North America. Of these specimens, 18 are Alaskan, 60 from eastern Canada (New Brunswick, except one from Quebec), approximately 150 from western Canada (British Columbia and Alberta), and a few from the state of Wyoming.

The Alaskan lichens, 15 species in all, are largely the usual arctic ground lichens. The New Brunswick lichens, which comprise 46 species, come from around Dalhousie and were collected in the year 1930 by the agronomist Tapio Reijonen. *Usnea longissima* was collected near Franklin, Quebec, by Dr. Viljo Kujala in 1931 during his scientific journey. On this same journey, he collected in western Canada (120 species, varieties, and forms) and in Wyoming (6 species). The latter specimens come from the sandstone in a cactus desert.

The lichens from western Canada were collected by Dr. Viljo Kujala in various types of forest in British Columbia in the following localities: Jackman, Longworth, Aleza Lake, Prince George, Six Mile Lake (Trout Lake), Hazleton, Dorreen, Cowichan Lake (Vancouver Island), Kamloops, Fish Lake (near Kamloops), Blue River, Valemount, Golden, Field, and in Alberta in the vicinity of Lake Louise. The desert lichens come principally from the vicinity of Kamloops in British Columbia and from Wainwright in Alberta.

Although the same species have been encountered in several different localities, the total number of species, varieties, and forms is 171 with 5 entirely new species, as follows: *Usnea Kujalae, Placodium xanthostigmoideum, Nephromium canadense, Diploschistes canadensis,* and *Sphaerophorus Tuckermanii.*

The list further includes eleven new varieties and forms, as follows: *Usnea comosa* var. *stuppea, Alectoria sarmentosa* var. *gigantea, A. Fremontii* f. *perfertilis, Cetraria nigricans* var. *pallida,*

[1] Duplicates of most of the specimens have been deposited in the herbarium of the Missouri Botanical Garden.

Issued April 29, 1933.

C. tenuifolia var. *reticulata*, *C. tenuifolia* var. *pseudoislandica* f. *septentrionalis*, *C. juniperina* var. *canadensis*, *C. juniperina* var. *crispata*, *Parmelia elegantula* var. *americana*, *Cyanisticta Hookeri* var. *septentrionalis*, *Mycoblastus sanguinarius* var. *Dodgeanus*.

Species new to North America or otherwise noteworthy include the following: *Usnea lapponica*, *U. dasypoga*, *U. caucasica*, *U. prostrata*, *U. rugulosa*, *U. similis*, *Alectoria Fremontii* subsp. *olivacea*, *A. jubata* var. *Vrangiana*, *Ramalina Roesleri*, *Ochrolechia upsaliensis*, *Pertusaria xanthostoma*, *Physcia pyrithrocardia*, *P. muscigena* f. *squarrosa*, *P. endophoenicea*, *Peltigera Maurizii*, *P. canina* var. *suomensis*, *P. lepidophora*, *P. Nylanderi*, *Cetraria Merrillii*, *Parmelia Delavayi*, *Squamaria alphoplaca*, *Nephromium subparile*, *Lobaria oregana*, *Diploschistes bryophiloides*.

The lichens collected by Dr. Kujala are principally epiphytic and soil-lichens from a variety of forest types, although a few of the soil lichens come from fields or desert. It might be interesting to note here that in regions as widely separated and isolated as the North American prairies and the south Russian and Asiatic steppes and deserts there appear many identical, or, at least similar, lichen forms living on the ground. Such steppe lichens are: *Parmelia vagans* (appearing also in south Russia and Asia), *Physcia muscigena* (many forms, a few also growing in the mountains), *Acarospora Schleicheri* (appears in the Asiatic, North-African, and Russian steppes, in addition to the European Alps and Pyrenees),[1] *Psora decipiens* (also in deserts and mountains), *Diploschistes canadensis* (the similar Russian *D. scruposus* var. *terrestris*), *Ochrolechia upsaliensis* (sporadically found outside of the steppes), *Cladonia cariosa* var. *cribrosa* (particularly on other mineral substrates, slightly calciphile).

As the lichens in this collection were not collected by a lichenologist, the lichen flora of the various localities is very poorly represented and poor in species. They are, however, of particular interest to the European investigator on account of the many similar forms. The typical European *Cetraria juniperina* and *C. islandica* do not appear at all amongst the American lichen specimens (the latter also being absent from the "*Cetraria islandica*" specimens collected in Tierra del Fuego by Professor Auer's expedition in 1929).

[1] Magnusson, Monogr. Acarospora. p. 395, 1929.

As the lichens from the various localities have not been sufficiently collected, conclusions as to the relationship between the American and European species are still hypothetical, particularly as the present systematic revision of lichens necessitates many corrections of the earlier determinations. We can, however, state that as far as our present knowledge extends a great number of identical lichen forms appear both in North America and Eurasia, although the quantitative relationships between the different species differ considerably on the two sides of the Atlantic.

I wish to acknowledge with thanks Dr. C. W. Dodge, Mycologist to the Missouri Botanical Garden, who has kindly translated my manuscript from German to English, and T. Hidén, of Helsinski, Finnland, who has gone over the latin text of this work.

Usnea dasypoga (Ach.) Röhl. New Brunswick: Dalhousie; British Columbia: Prince George and Six Mile Lake, on *Picea*. Sterile.

Usnea dasypoga var. subscabrata Vain. British Columbia: Hazleton, on *Betula* and *Pinus*. Sterile.

Usnea caucasica Vain. Thallus prostratus, glauco-viridis, medulla sublaxa, K—.—British Columbia: Six Mile Lake, on *Picea*. Fertile.

Usnea prostrata (Vain.) Räs. British Columbia: Aleza Lake, on *Picea*. Sterile.

Usnea rugulosa Vain. British Columbia: Hazleton, on trunks of *Pinus Murrayana*. Sterile.

Usnea longissima Ach. Quebec: north shore of the St. Lawrence Bay, Franklin, especially on branches of *Picea* in a mixed forest; British Columbia: Vancouver, Catillano Canyon, on *Thuja* in a forest with abundant ferns. Sterile.

Usnea comosa (Ach.) Vain. Thallus erectus, parce sorediosus, soredia isidiosa; medulla crebra, K—.—New Brunswick: Dalhousie, on *Picea;* British Columbia: Hazleton, rarely on branches of *Pinus Murrayana*. Sterile.

Usnea comosa var. **stuppea** Räs., var. nov. Thallus erectus aut suberectus, brevior fruticulosus, 5–7 cm. longus, laevigatus vel leviter verrucosus, sorediosus, pallido-stramineus; soredia maculiformia, demum parce isidiosa. Medulla laxa, stuppea, K—.—British Columbia: Hazleton, very frequent on small, half-dried *Pinus*, *Picea*, and *Betula*, on a sandy heath. Sterile.

Usnea similis Motyka

U. subcomosa Vain. in Kgl. Danske Vidensk. Selsk. Skrifter, Nat. og Math. Afd. VIII. **6**: 392 (110). 1924.

With the above species, occasional in Hazleton. Sterile.

Usnea lapponica Vain. With the above species, Hazleton, on *Pinus*. Sterile.

Usnea hirta (L.) Motyka. British Columbia: Aleza Lake, occasional on *Picea canadensis* and *P. Engelmannii*. Sterile.

Usnea **Kujalae**[1] Räs., sp. nov. Thallus curtus, erectus, fruticulosus, 3–5 cm. longus, bene ramosus, lacteo-stramineus vel albo-viridis, sorediosus. Rami laevigati, sine verruculis nervisque. Medulla laxissima, K—. Apothecia rara, terminalia, 2–3 mm. lata, albido-straminea, fibrillosa, plana. Sporae 9–10 × 5.3–7 μ, ovoideo-

[1] In honor of Dr. Viljo Kujala.

ellipsoideae, 8 : nae, monostichae. Asci cylindrici. Hymenium 80 μ crassum, I+, caerulescens. Subsimilis *Usneae sorediiferae* Motyka, sed thallus albidus et parce sorediosus.—British Columbia: Hazleton, abundant on branches of *Pinus Murrayana*. Rarely fertile.

ALECTORIA SARMENTOSA Ach. Thallus elongatus, pendulus vel prostratus, K = K(Cl) ∓ leviter roseus, demum ferrugineus, I ∓ leviter caerulescens. Sporae normaliter binae vel 4:nae, fuscae.—British Columbia: Aleza Lake, frequent on branches of *Abies lasiocarpa*, *Picea canadensis*, and *P. Engelmannii;* Longworth, frequent on branches of *Thuja;* Hazleton, rarely on *Pinus*. Fertile.

ALECTORIA SARMENTOSA var. **gigantea** Räs., var. nov. Thallus elongatus, pendulus vel prostratus, 50–80 cm. longus, albido-stramineus, parce pseudocyphellatus, esorediatus, K =, K(Cl) =, Cl =, I = leviter caerulescens. Apothecia vulgaria, plana vel concava, atro-fusca vel livido-fusca, nuda vel leviter pruinosa. Sporae normaliter 3:nae, 25–31 × 14.5–20 μ, ellipsoideae, fusco-nigrae. Hymenium 130 μ crassum, I+ caerulescens.—British Columbia: Longworth, frequent on *Thuja;* Dorreen, on *Pseudotsuga*.

ALECTORIA LAETA (Tayl.) Linds.

A. japonica Tuck., *A. osteina* Nyl., *A. lata* DR. (Arkiv f. Bot. 20[11]: 24. 1926).

Thallus suberectus vel prostratus, osteo-ochroleucus, apicem versus concolor, K± passim obsolete intensive fulvescens, K(Cl) ∓ roseus.—British Columbia: Hazleton, occasional on the ground; Alaska, occasional on the ground. Sterile.

ALECTORIA OCHROLEUCA (Ehrh.) Nyl. Thallus pro parte ochroleucus, majore parte viridi-niger, K = vel basim versus obsolete ± dilute fulvescens, K(Cl) =.—Alaska, on the ground. Sterile.

ALECTORIA IMPLEXA (Hoffm.) Nyl. f. FUSCIDULA Arn. Thallus pallido-fuscescens, K± lutescens, sorediosus. Soredia albida.—British Columbia: Hazleton, on branches of *Pinus*, Aleza Lake, on branches of *Abies* and *Picea*. Sterile.

ALECTORIA JUBATA (L.) Nyl. var. PROLIXA Ach. Thallus fuscescens vel nigrofuscescens, K =, sorediosus. Soredia copiosa, albida.—New Brunswick: Dalhousie, on trunks of *Abies;* British Columbia: Kamloops, Fish Lake, Golden, and Aleza Lake, very frequent on branches and trunks of *Pseudotsuga* and *Pinus Murrayana*. Also on conifers near Hazleton. Sterile.

ALECTORIA JUBATA var. VRANGIANA (Gyeln.) Räs.

A. Vrangiana Gyeln. (Magyar Bot. Lap. **31**: 46. 1932).

Thallus parce sorediosus, vel fere esorediatus, olivaceo-viridis vel fusco-viridis, K =, K(Cl) =.—British Columbia: Hazleton, on conifers, occasional. Sterile.

ALECTORIA FREMONTII Tuck. f. **perfertilis** Räs., forma nov. Thallus prostratus, obscuro-castaneo-fuscus, laevis, subnitidus, esorediatus, K =, Cl =, K(Cl) =. Apothecia vulgaria numerosissima, lateralia, convexa, flavida. Sporae 5–8 × 5 μ, ovoideae, 8 : nae, hyalinae. Hymenium I+ caerulescens.—British Columbia: Golden, on the trunks and branches of *Pinus Murrayana*.

ALECTORIA FREMONTII subsp. OLIVACEA Räs. Thallus olivaceo-castaneus, prostratus, laevis, nitidus, esorediatus, K =, Cl =, K(Cl) =. Apothecia rarissima, minora, flavida.—British Columbia: Golden, on *Pinus Murrayana* and *Pseudotsuga*, Kamloops, Fish Lake, on *Pinus Murrayana*. Sterile.

The sorediose form, named by Du Rietz (Arkiv f. Bot. 20[11]: 8. 1926) subsp. *Eriksonii*, was not seen among the North American specimens. It would appear more correct, as Du Rietz (*l. c.*) thinks, not to regard the sorediose form as the main species. My subspecies *olivacea* (Räsänen, Medd. Soc. Fauna Flora Fennica **43**: 4.

1916) is much shinier than the North American type and has very rare apothecia, so that we have here three different *Alectoria* types.

RAMALINA THRAUSTA (Ach.) Nyl. British Columbia: Hazleton, on branches of conifers, Prince George and Six Mile Lake, on *Picea*. Sterile.

RAMALINA GENICULATA Nyl. British Columbia: Hazleton, on branches of *Pinus Murrayana*, rare. Sterile.

RAMALINA ROESLERI (Hochst.) Nyl. New Brunswick: Dalhousie, on branches of *Picea*, *Sorbus*, and on a wooden wall. Sterile.

RAMALINA CALICARIS (L.) Fr. New Brunswick: Dalhousie, on trunks of *Populus*. Fertile.

LETHARIA VULPINA (L.) Vain. Thallus corediosus. Medulla I+ caerulescens.—British Columbia: Kamloops, Fish Lake, and Field (subalpine), on branches and trunks of *Pseudotsuga*. Sterile.

LETHARIA VULPINA f. INCOMPTA Ach. Thallus sorediosus et bene isidiosus, medulla I+ caerulescens.—Found with the species near Fish Lake, Golden, and Jackman, B. C., on *Pinus Murrayana*. Sterile.

CORNICULARIA DIVERGENS Ach. Alaska (alpine), on the ground. Sterile.

CETRARIA MERRILLII DR.

C. californica var. *Tuckermanii* Howe

Thallus 0.5–2 cm. longus, rigidus, erectus, divaricato-ramosus, opacus, olivaceoniger. Rami angulato-nervosi, foveolati. Apothecia vulgaria, 0.5–3 mm. lata, plana vel convexa, terminalia, atra vel fusco-nigra, nuda, subnitida, subciliata. Sporae 8:nae, 6–8 × 4–5.5 μ, ovoideae, incoloratae.—British Columbia: Golden, Kamloops, Fish Lake, and Hazleton, on branches of *Pinus Murrayana* and other conifers. Fertile.

CETRARIA NIGRICANS Nyl. var. **pallida** Räs., var. nov. Thallus superne pallidus vel olivaceo-pallidus, subtus albidus, basim versus sanguineo-lentus; medulla I+ caerulescens. Laciniae 1–2 mm. latae, subcanaliculatae, denticulato-ciliatae, dichotome ramosae.—Alaska, on the ground with *Alectoria ochroleuca* and *Cornicularia divergens*. Sterile.

CETRARIA TENUIFOLIA (L.) Vain. Thallus canaliculatus, laevigatus, medulla K−.—Alaska, rarely with the previous species. Sterile.

CETRARIA TENUIFOLIA var. **reticulata** Räs., var. nov. Thallus subtus foveato-reticulatus, castaneo-fuscus, in marginibus dense isidioso-dentatus. Laciniae angustae, canaliculato-tubulosae, crispatae, marginem versus pseudocyphellatae. Medulla K−.—British Columbia: Kamloops, on stones, Valemount and Aleza Lake, on the ground. Sterile.

CETRARIA TENUIFOLIA var. PSEUDOISLANDICA Räs. (Ann. Bot. Soc. Zool.-bot. Fenn. Vanamo 2: 15. 1932) f. **septentrionalis** Räs., forma nov. Medulla I−. Thallus similis *C. islandicae*, sed I−, et margo laciniarum fere sine spinis vel ciliis. Color pallido-castaneus.—British Columbia: Golden, on trunks and branches of dwarf shrubs near the ground. Sterile.

The true *Cetraria islandica* (L.) Ach., which gives the reaction "Medulla I lutescens, demum ferrugineo-rubescens," has not been seen by me from either North or South America.

CETRARIA NIVALIS (L.) Ach. British Columbia: Kamloops, on the ground and rocks in semi-desert; Alaska, on the ground. Sterile.

CETRARIA CUCULLATA (Bell.) Ach. British Columbia: Valemount, on the ground with *Arctostaphylos Uva-ursi;* Alaska (alpine), on the ground. Sterile.

Cetraria caperata (L.) Vain.

C. pinastri (Scop.) Röhl.

British Columbia: Hazleton, a small specimen with other *Cetraria* species on branches of *Pinus Murrayana*, Aleza Lake, a chiefly geoplese lichen (Räsänen, Über Flechtenstand u. Fl. Veget. im Westl. Nordfinnl., p. 84. 1927), with *Parmelia ambigua* and *P. pallescens* on the base of *Abies lasiocarpa*. Sterile.

Cetraria juniperina (L.) Fr. var. viridis (Schweinitz) Räs.

C. viridis Schweinitz apud Halsey, Ann. Lyceum Nat. Hist. New York **1**: 16. 1824; *C. juniperina* var. *virescens* Tuck.

Thallus curtus, rigidus; laciniae obtusae, obscuro-virides; K=, Cl=, I=. Apothecia terminalia, majora, 3–8 mm. lata, fusco-nigra, subnitida, margo subcrenata, tenuis. Sporae 8 : nae, ovoideae, 6–8 × 3.5–6.5 μ, incoloratae.—British Columbia: Golden, common on branches of *Pinus Murrayana*. Fertile.

Cetraria juniperina var. **canadensis** Räs., var. nov. Thallus erectus vel suberectus, subrigidus; laciniae obtusae, aureo-flavae vel interdum viridi-flavae, super reticulato-nervosae, intus flavae. Apothecia terminalia, minora, 1–3 mm. lata, castaneo-fusca, nitida; margo lacerato-crenata. Sporae 6.5–8 × 4–5.2 μ, ovoideae, 8:nae, hyalinae.—British Columbia: Kamloops, Fish Lake, Aleza Lake, and Hazleton, very frequent on twigs of conifers.

C. juniperina (the main species) has apothecia chiefly in the middle of the thallus and the lobes are very divided. Also, the color of this species is not so bright a golden yellow as in the variety *canadensis*, and the surface is furthermore much smoother in the species.

Cetraria juniperina var. **crispata** Räs., var. nov. Sicut var. *canadensis*, sed thallus dense lacerato-crispatus vel subpapillatus. Apothecia rara. Est analogica cum *C. juniperina* var. *terrestris* Schaer. (= *C. Tilesii* Ach. in Zahlbr. Cat. Lich. Univ. **6**: 341. 1930).—British Columbia: Golden, rarely on branches of *Pinus Murrayana* with var. *viridis*. Fertile.

Cetraria aleurites (Ach.) Th. Fr. New Brunswick: Dalhousie, on trunks of *Abies* and on wood. Sterile.

Cetraria chrysantha Tuck.

Platysma septentrionale Nyl.

Thallus stramineus, lacunoso-nervosus, esorediatus, subtus fusco-niger, K± lutescens, Cl=, K(Cl)∓ roseus, I=.—Alaska (alpine), on the ground. Sterile.

Cetraria lacunosa Ach. var. Macounii DR. Thallus subtus fusco-niger, non isidiosus, I=.—British Columbia: Kamloops, on stones in semi desert. Sterile.

Cetraria norvegica (Lynge) DR. Thallus isidiosus, I=.—With the above species in Kamloops, on stones. Sterile.

Cetraria glauca (L.) Ach. Thallus I∓ caerulescens.—With the above species in Kamloops, on stones; Prince George, Six Mile Lake, abundant on *Picea;* Aleza Lake and Vancouver, on branches of *Picea*. Sterile.

Cetraria glauca var. stenophylla Tuck. (Syn. North Amer. Lich. **1**: 36. 1882). Thallus I∓ caerulescens, anguste laciniatus, glaucus, subtus niger.—British Columbia: Vancouver Is., Lake Cowichan, occasional on the lower branches of *Picea* in the forest. Sterile.

Cetraria scutata (Wulf.) Poetsch

C. chlorophylla (Willd.) Dalla Torre et Sarnth

British Columbia: Kamloops, Fish Lake, Golden, Hazleton, Aleza Lzke, on the branches of *Pinus Murrayana* and *Abies;* Vancouver Is., Lake Cowichan, occasional on *Thuja gigantea*. Sterile.

NEPHROMOPSIS PLATYPHYLLA (Tuck.) Herre

Cetraria platyphylla Tuck.

Thallus 1–3 cm. latus, irregulariter laciniatus, super opacus, obscure fuscus, tuberculosus, subtus pallide fuscus, reticulato-nervosus. Apothecia marginalia, minora, 1–2 mm. lata, plana, fusca, tenuiter marginata; margo crenata. Sporae sphaeroideae vel subellipsoideae, 8:nae, incoloratae, 4–6.5 μ. Hymenium ca. 50 μ crassum, I+ caerulescens.—British Columbia: Golden, on twigs of *Pinus Murrayana*.

NEPHROMOPSIS CILIARIS (Ach.) Hue. British Columbia: Aleza Lake, a small specimen on *Pinus Murrayana*. Sterile.

PARMELIA PALLESCENS (Neck.) Räs.

P. hyperopta Ach.

New Brunswick: Dalhousie, on trunk of *Abies;* British Columbia: Aleza Lake, on base of *Abies lasiocarpa* as a geoplese lichen. Sterile.

PARMELIA AMBIGUA (Wulf.) Ach. New Brunswick: Dalhousie, on wood; British Columbia: Aleza Lake, on base of *Abies lasiocarpa* and *Pinus Murrayana*. Sterile.

PARMELIA PHYSODES (L.) Ach. f. LABROSA Ach. New Brunswick: Dalhousie, on trunk of *Abies;* British Columbia: Aleza Lake, on trunks of *Picea*, Kamloops, on *Pinus Murrayana*. Sterile.

PARMELIA PHYSODES f. VITTATA Mereshk. British Columbia: Aleza Lake and Hazleton, on branches of *Pinus Murrayana*. Sterile.

PARMELIA LOPHYREA Ach. Thallus cinereus, esorediatus, K± lutescens, K(Cl) ∓ roseus. Apothecia vulgaria, subtus ampullacea, demum ca. 5 mm. lata. Sporae sphaeroideae, 2.5–5 μ, 8 : nae, incoloratae. Hymenium 50 μ crassum, I+ caerulescens.—British Columbia: Golden, on branches of *Pinus Murrayana;* Aleza Lake, on branches of *Picea*.

PARMELIA DELAVAYI (Hue) Nyl. Thallus parvus, esorediatus, obscure cinereus. Apothecia vulgaria, demum 5 mm. lata, subtus non ampullacea, discus fuscus, urceolatus vel deplanatus. Sporae 5–7 × 4–5 μ, 8 : nae, ovoideae. Hymenium ca. 55 μ crassum, I+ caerulescens.—British Columbia: Golden, on *Pinus Murrayana*.

PARMELIA ENTEROMORPHA Ach. Thallus esorediatus, ventricoso-inflatus, cavus, K± lutescens, K(Cl) =.—British Columbia: Vancouver Is., Lake Cowichan, on trunk of *Thuja gigantea*. Sterile.

PARMELIA VITTATA (Ach.) Röhl. British Columbia: Prince George, Six Mile Lake, on trunk of *Betula?*. Sterile.

PARMELIA SULCATA Tayl. New Brunswick: Dalhousie, on trunks of *Betula, Sorbus, Picea, Abies*, and on wood; British Columbia: Prince George, Six Mile Lake, on *Betula;* Hazleton, on *Betula;* Golden, on *Pinus Murrayana* and *Pseudotsuga;* Kamloops on arid ground. Sterile.

PARMELIA VAGANS Nyl.

P. molliuscula Tuck. (Syn. North Amer. Lich. 1: 64. 1882).

Thallus dichotome laciniatus, sine sorediis et isidiis, stramineo-virens, K ∓ fulvescens.—British Columbia: Kamloops, on the ground between grasses and shrubs. Sterile. The lichen is a typical desert lichen and appears also in such environment in Russia and Asia.

PARMELIA SUBAURIFERA Nyl. New Brunswick: Dalhousie, on the trunk of *Sorbus;* British Columbia: Hazleton, on the trunk of a *Populus*. Sterile.

PARMELIA PAPULOSA (Schaer.) Vain.

P. exasperatula Nyl.

New Brunswick: Dalhousie, on the trunk of *Sorbus*. Sterile.

Parmelia elegantula (Zahlbr.) Räs. var. **americana** Räs., var. nov. Thallus opacus, obscure olivaceo-fuscescens, isidiosus, K=, Cl=, K(Cl)=. Isidia subcylindrica, curta, concoloria. Apothecia desunt.—British Columbia: Kamloops, on a *Pseudotsuga* in semi-desert.

Parmelia pubescens (L.) Vain. var. reticulata Cromb. British Columbia: Kamloops, on a stone in semi-desert. Sterile.

Thamnolia vermicularis (Sw.) Schaer. Alaska (regio alpina), on the ground between tufts of *Cornicularia divergens* and *Cladonia rangiferina*. Sterile.

Siphula ceratites (Wahlbg.) Fr. British Columbia: Dorreen, on stones in moist mountain forest. Sterile.

Stereocaulon tomentosum Fr. British Columbia: Dorreen, on branches of *Tsuga;* Alberta: Lake Louise, on mossy earth; Alaska (regio alpina), between *Cornicularia divergens* and *Cetraria chrysantha*. Rarely fertile.

Lecania dimera (Nyl.) Th. Fr. British Columbia: Aleza Lake, very common on the trunks of *Populus*. Fertile.

Squamaria alphoplaca (Wahlbg.) Dub. Thallus orbicularis, radiatus, griseus, K+ partim rubescens. Medulla I−. Apothecia ca. 1 mm. lata, nigra, nuda vel tenuiter pruinosa. Sporae 9, 6.5 μ, 8 : nae.—U. S. A.: Cody, Wyoming, on sandstone in a cactus desert.

Aspicilia calcarea (L.) Mudd. With the previous on sandstone in cactus desert, in Cody. Fertile.

Lecanora coilocarpa (Ach.) Nyl. New Brunswick: Dalhousie, on a rail fence. Fertile.

Lecanora umbrina (Ehrh.) Röhl. New Brunswick: Dalhousie, on a stone in a field. Fertile.

Lecanora symmicta Ach. Thallus areolato-verruculosus, mox totus sorediosus, virescens, K−, Cl+ aurantiaco-rubescens. Apothecia livida, mox convexa, fere immarginata.—New Brunswick: Dalhousie, on a wood rail fence.

I have found the same lichen—not in any way to be confused with *Biatora symmictera* (Nyl.) Räs.—in the summer of 1931, on a wooden fence in Petsamo, Finnland. Except for this I have not seen this central European and North American species.

Lecanora subintricata Nyl. British Columbia: Kamloops, Fish Lake, on trunks and branches of *Pinus Murrayana*. Fertile.

Ochrolechia upsaliensis (L.) Mass. Thallus K−, Cl−, K(Cl)−. Epithecium K(Cl)−. Apothecia 1–2 mm. lata, planiuscula vel urceolata, pruinosa. Margo crassa, subrugosa.—British Columbia: on rotting vegetable remains in somewhat shaded positions in the semi-desert.

Phlyctis argena (Ach.) Flot. New Brunswick: Dalhousie, on trunk of *Abies* sp. Sterile.

Pertusaria pertusa (L.) Tuck. New Brunswick: Dalhousie, together with previous species on *Abies*. Fertile.

Pertusaria xanthostoma (Smrft.) Fr. Thallus verruculoso-inaequalis, K−, K(Cl)−. Apothecia 0.5 mm. lata, punctiformia, pallido-lutescentia. Excipulum K+, sanguineo-rubescens. Sporae 4:nae, ellipsoideae, incoloratae, 58–66 $\times$ 26–40 μ. Hymenium I+ caerulescens.—New Brunswick: Dalhousie, on a *Thuja* trunk.

Pertusaria multipuncta (Turn.) Nyl. British Columbia: Aleza Lake, on the trunk of an *Abies*. Fertile.

Pertusaria faginea (L.) Vain.

P. amara (Ach.) Nyl.

Thallus albidus, partim albo-sorediosus, K+ demum rubescens, K(Cl)+ mox violascens.—With the previous species on an *Abies* at Aleza Lake. Sterile.

XANTHORIA POLYCARPA (Hoffm.) Flag. New Brunswick: Dalhousie, on a *Sorbus* and a rail fence. Fertile.

PLACODIUM ELEGANS (Link) DC. New Brunswick: Dalhousie, on a field stone. Fertile.

PLACODIUM FERRUGINEUM (Huds.) Rabenh. New Brunswick: Dalhousie, on the fibrous trunks of a *Thuja*. Fertile.

PLACODIUM **xanthostigmoideum** Räs., n. sp. Thallus totus leproso-granulosus, citrinus vel aurantiaco-citrinus, K+ violascens. Similis *Candelariellae xanthostigmae* (Pers.) Lettau, sed thallus K+.—New Brunswick: Dalhousie, on the trunks of *Betula*, *Abies*, and *Thuja*. Sterile.

Placodium chrysodetum Vain. also has leprous thallus and positive K (violascens) reaction, but this lichen is exclusively confined to stones and may grow over dead mosses on stones. *Placodium citrinum* (Hoffm.) Hepp., a typical calcareous lichen, may also grow on trees and wooden houses which are impregnated with chalk dust, but is not entirely leprous and its color is "flavo-citrina vel cerina" and it frequently has apothecia.

PHYSCIA CLEMENTIANA (Ach.) Kickx.

Ph. astroidea Nyl.

Thallus albidus vel canus in centro granuloso-sorediosus, K^{+}_{+} lutescens.—New Brunswick: Dalhousie, on the bark and on the peeled trunks of *Picea*. Sterile.

PHYSCIA STELLARIS (L.) Nyl. New Brunswick: Dalhousie, with the previous species on *Picea*. Sterile.

PHYSCIA STELLARIS var. ROSULATA (Ach.) Nyl. New Brunswick: Dalhousie, on a trunk of *Betula*. Fertile.

PHYSCIA CAESIA (Hoffm.) Nyl. New Brunswick: Dalhousie, with *Placodium elegans* on a field stone. Sterile.

PHYSCIA MUSCIGENA (Ach.) Nyl. British Columbia: Kamloops, on the ground between mosses and grasses in a semi-desert. Sterile.

PHYSCIA MUSCIGENA f. LENTA (Ach.) Vain. British Columbia: Kamloops, with the previous species on the ground in semi-desert. Sterile.

PHYSCIA MUSCIGENA f. SQUARROSA (Ach.) Lynge. Thallus 6–8 cm. latus, imbricatus, albo-pruinosus; laciniae curtae, obtusae, adscendentes. Apothecia 1–3 mm. lata, plana, albo-pruinosa, marginata. Sporae 15–26 × 8–15 μ, fuscae.—British Columbia: Kamloops, with the previous species on the ground in semi-desert.

PHYSCIA GRISEA (Lamy) Zahlbr. var. SEMIFARREA (Vain.) Lynge. British Columbia: Kamloops, on the ground between grasses and *Selaginella*. Sterile.

PHYSCIA PYRITHROCARDIA (Müll.-Arg.) Räs.

Ph. adglutinata var. *pyrithrocardia* Müll.-Arg.

Thallus centrum versus tote isidioso-sorediosus, viridi-griseus, intus erythrinus, K=.—New Brunswick: Dalhousie, on the trunk of *Picea*. Sterile.

PHYSCIA ENDOPHOENICEA (Harm.) Räs. Sicut *Ph. obscura* (Ehrh.) Nyl. f. *ciliata* (Hoffm.) Lynge, sed thallus fusco-niger et intus pulchre rubescens. Thallus K∓ violascens.—New Brunswick: Dalhousie, on trunk of *Betula*, with *Placodium xanthostigmoideum*. Sterile.

RINODINA DEMISSA (Flk.) Mass. New Brunswick: Dalhousie, on a field stone. Fertile.

BUELLIA DISCIFORMIS (Fr.) Mudd var. MINOR (Fr.) Räs. New Brunswick: Dalhousie, on a *Populus* trunk. Fertile.

Buellia disciformis var. insignis (Naeg.) Nyl. f. muscorum (Schaer.) Räs. British Columbia: Kamloops, on mosses growing on stones in a semi-desert. Fertile.

Buellia major (DN.) Mass. New Brunswick: Dalhousie, on trunks of *Sorbus, Picea*, and *Abies*. Fertile.

Buellia punctiformis (Hoffm.) Mass. f. chloropolia (Fr.) Vain. British Columbia: Kamloops, on the trunk (bark) of a very well-lighted *Pseudotsuga*. Fertile.

Peltigera variolosa (Mass.) Körb. Subsimilis *Peltigerae aphthosae* sed thallus subtus distincte nervosus et superne marginem versus subpruinosus.—British Columbia: Field, on the ground between mosses and grasses. Sterile.

Peltigera venosa (L.) Körb. British Columbia: Dorreen, on mineral soil in shaded forest. Fertile. In the dozen individuals from Dorreen the apothecia are much smaller (about 1 mm.) than in the Finnish specimens, so that one might regard the American species as a new variety (var. *microcarpa* Räs.).

Peltigera horizontalis (L.) Hoffm. British Columbia: Prince George, Six Mile Lake, on mossy stone walls. Fertile.

Peltigera Maurizii Gyeln. (Hedwigia **68**: 1. 1928). Thallus circiter 6 cm. latus, superne laevis, nitidus, epruinosus et etomentosus, cinereus vel cinereo-fuscescens, subtus malaceaeforme nervosus, obscuro-fuscus, marginem versus pallidior; rhizinae nigro-fuscae, fasciculatae, obsoletae. Apothecia horizontalia, plana vel concava, badio-fusca, 3–5 mm. lata; margo subintegra. Sporae 26–43 $\times$ 3.5–6 μ, fusiformes, 3-septatae, hyalinae. Hymenium 80–83 μ crassum, sordide-hyalinum, I+ caerulescens.—British Columbia: Field, on ground between mosses and other ground lichens. This easily recognizable lichen is a form intermediate between *Peltigera malacea* and *P. horizontalis*.

Peltigera malacea (Ach.) Fr. British Columbia: Valemount, on an *Arctostaphylos* and lichen heath. On the ground. Sterile.

Peltigera canina (L.) Willd. British Columbia: Kamloops, on mossy stones in semi-desert. Fertile.

Peltigera canina var. membranacea Ach. British Columbia: Field, with *Peltigera Maurizii* and *P. variolosa*, on the ground in a forest of *Picea*. Fertile.

Peltigera canina var. suomensis (Gyeln.) Räs.

P. suomensis Gyeln. (Magyar Bot. Lap. **29**: 34. 1930).

British Columbia: Blue River, on the ground in a burnt-over *Myrtillus* forest. Fertile.

Peltigera rufescens (Weis) Humb. British Columbia: Kamloops, on the ground in semi-desert. Fertile.

Peltigera microphylla (Anders.) Gyeln.

P. perfida Gyeln.

Thallus superne cinereo-fuscescens, laevigatus, nitidus, subtus polydactylaeforme venosus, marginem versus squamuloso-isidiosus. Apothecia junior involuta.—New Brunswick: Dalhousie, on ground in coniferous forest.

Peltigera lepidophora (Nyl.) Bitt. Alberta: Wainwright, on calcareous earth, together with *Cladonia cariosa*, in a desert. Rare and sterile.

Peltigera Nylanderi Gyeln. (Bot. Közlem. **24**: 137. 1927). Thallus pusillus, 1–2 cm. latus, firmus, monophyllus, laciniatus, ad marginem bene limbiformiterorediosus, subtus caninaeforme venosus.—British Columbia: Kamloops, between mosses on stones in semi-desert. Sterile.

Nephromium subparile Gyeln. (Magyar Bot. Lap. **29**: 24. 1930). Thallus

superne et ad marginem bene granuloso-sorediosus, etomentosus (glaber), subtus glaber, K = .—British Columbia: Kamloops, on stones in semi-desert. Sterile.

NEPHROMIUM LAEVIGATUM Ach. var. PAPYRACEUM (Hoffm.) Nyl. Thallus pusillus, tenuis, superne glaucus, K =, subtus albido-pallens, glaber. Apothecia majora, 3–8 mm. lata, horizontalia, fusca; margo subintegra. Sporae pallidae, 16–21 × 4–5 μ, 1- vel 3-septatae, oblongo-fusiformes.—British Columbia: Aleza Lake, on branches of *Picea* in the forest.

NEPHROMIUM **canadense** Räs., n. sp. Thallus 5 cm. latus, subrigidus, coriaceus, bene laciniatus, ad marginem dentatus vel lacunate dentatus, superne sublaevigatus, apicem versus scabroso-areolatus, passim leviter hirsutus vel totus nudus, griseo-pallidus vel glauco-fuscescens, subtus tomentellus, pallido-fuscescens. Apothecia vulgaria, 3–6 mm. lata, convoluta, fusca; margo dentata. Sporae 3-septatae, pallidae, oblongae vel oblonge fusiformes, 14.5–21 × 7–8 μ. Hymenium 70 μ crassum. I+ caerulescens. Gonidia nostocoidea.—British Columbia: Aleza Lake, together with *Nephromium laevigatum* var. *papyraceum* and *Cyanisticta Hookeri* var. *septentrionalis*, on branches of *Picea* in forest.

SOLORINA SACCATA (L.) Ach. British Columbia: Field, on a tree base. Fertile.

LOBARINA VERRUCOSA (Huds.) Gyeln.

Sticta scrobiculata (Scop.) Ach.

New Brunswick: Dalhousie, on a tree trunk, rare. Sterile.

LOBARIA PULMONARIA (L.) Hoffm. Thallus ad marginem sorediosus, non isidiosus; medulla et soredia K+ flavescentia.—New Brunswick: Dalhousie, on *Abies* and *Betula* trunks. Sterile; British Columbia: Aleza Lake, on branches and trunks of *Picea*. Fertile.

LOBARIA LINITA (Ach.) Rabenh. Thallus esorediatus, K = .—Alaska (regio alpina), on the ground between *Cladonia* species and mosses. Sterile and rare.

LOBARIA OREGANA (Tuck.) Müll.-Arg. Thallus majus, 30 cm. longus et 3–10 cm. latus, dichotome laciniatus, lacunoso-reticulatus, viridi-glaucus, esorediatus, basim versus demum squamulosus; laciniae in apicibus rotundata. Apothecia vulgaria, in centro aut submarginalia, plana aut demum convexa, castaneo- vel rufo-fusca; margo tenuis. Sporae 40–61 × 6–8 μ, hyalinae, fusiformes, 1-septatae. Hymenium 100–120 μ crassum, incoloratum, I+, caerulescens. Hypothecium 60 μ crassum, K+ lutescens. Thallus K∓ lutescens, Cl =, K(Cl) =, I = .—British Columbia: Hazleton, on *Pinus Murrayana*, Dorreen, on *Pseudotsuga*, and Vancouver Is., Lake Cowichan, on trunks of *Thuja* and *Tsuga*.

STICTINA FULIGINOSA (Dicks.) Nyl. British Columbia: Aleza Lake, common on branches of *Picea* in forest. Sterile.

CYANISTICTA HOOKERI (Bab.) Räs. var. **septentrionalis** Räs., var. nov. Thallus superne glauco-cinereus, subnitidus, scrobiculatus, isidiosus, subtus obscure rhizinosus. Pseudocyphellia minora, papilliformia, albida. Gonidia nostocoidea.—British Columbia: Aleza Lake, on branches of *Picea*. Sterile.

COLLEMA NIGRESCENS (Huds.) Ach. New Brunswick: Dalhousie, on *Populus* trunks. Sterile.

LEPTOGIUM TREMELLOIDES (L.) Fr. New Brunswick: Dalhousie, on *Abies* trunks. Sterile.

LEPTOGIUM SATURNINUM (Dicks.) Mass. British Columbia: Kamloops, on side of a stone in semi-desert. Sterile.

PILOPHORON ACICULARE (Tuck.) Nyl. Thallus 2.5–3.5 cm. longus, simplex vel parce ramosus, corticatus, viridis, K+ lutescens. Apothecia sphaeroidea vel sub-

conica, vulgaria, nigra vel caeruleo-nigra. Sporae hyalinae, oblongo-fusiformes, simplices, 18–21 × 5–6 μ. Epithecium caeruleum, K+ smaragdulum. Hypothecium fuligineum. Hymenium 60–130 μ, crassum, incoloratum, I+ caerulescens.—British Columbia: Dorreen, frequent on stones between plant remains (fallen needles, etc.) in mountain forest.

CLADONIA RANGIFERINA (L.) Rabenh. Alaska (regio alpina), on ground. Sterile.

CLADONIA RANGIFERINA f. NIVEA Räs. Thallus niveus, K+ lutescens.—British Columbia: Dorreen, on an arid heath in *Pinus Murrayana* forest. Sterile.

CLADONIA SILVATICA (L.) Rabenh. Alaska (regio alpina), on ground; British Columbia: Dorreen, on an arid heath among *Pinus Murrayana*. Fertile.

CLADONIA SILVATICA var. MITIS (Sandst.) Räs. British Columbia: Valemount, on an arid heath with *Arctostaphylos Uva-ursi*. Sterile.

CLADONIA ALPESTRIS (L.) Rabenh. Alberta: Lake Louise, on an *Empetrum* heath. Common. Sterile.

CLADONIA BACILLARIS Nyl. New Brunswick: Dalhousie, on a very rotten rail fence. Fertile.

CLADONIA CRISTATELLA Tuck. New Brunswick: Dalhousie, in same situation as previous species. Fertile.

CLADONIA DEFORMIS Hoffm. Alberta: Lake Louise, on an arid heath between other *Cladonia* species and mosses. Sterile.

CLADONIA UNCIALIS (L.) Fr. Alaska (regio alpina), on ground; British Columbia: Valemount, on an *Arctostaphylos-Cladina* heath. Fertile.

CLADONIA CRISPATA (Ach.) Flot. var. INFUNDIBULIFERA (Schaer.) Vain. British Columbia: Valemount, with previous species on an *Arctostaphylos-Cladina* heath. Fertile.

CLADONIA CRISPATA var. ELEGANS (Del.) Vain. British Columbia: Blue River, on a burnt-over *Vaccinium Myrtillus* heath. Fertile.

CLADONIA CENOTEA (Ach.) Schaer. var. CROSSOTA (Ach.) Nyl. British Columbia: Valemount, on an *Arctostaphylos-Cladina* heath. Sterile.

CLADONIA CARIOSA (Ach.) Spreng. f. CRIBROSA (Wallr.) Vain. Alberta: Wainwright, on ground in desert with *Peltigera lepidophora*. Fertile. As both species grow on calcareous soil, one may conclude that the soil in these deserts is calcareous.

CLADONIA GRACILIS (L.) Willd. var. DILATATA (Hoffm.) Vain. New Brunswick: Dalhousie, on a very rotten rail fence; British Columbia: Golden, on a sand heath; Valemount, on an *Arctostaphylos-Cladina* heath; Alberta, Lake Louise, on an arid heath. Fertile.

CLADONIA GRACILIS f. ANTHOCEPHALA Flk. British Columbia: Field (regio subalpina), on a *Vaccinium Myrtillus* heath; Blue River, on a *V. Myrtillus* heath, which had been burnt over. Fertile.

CLADONIA ELONGATA (Jacq.) Hoffm. Alaska (regio alpina), on mossy ground. Sterile.

CLADONIA ELONGATA var. ECMOCYNA (Ach.) Räs. Podetia cornuta vel subcornuta, saepe dilatata, scyphifera, glauco-cinerea, K− pulchre lutescentia.—Alberta: Lake Louise, on a dry heath; British Columbia: Field (regio alpina), on heath under *Phyllodoce*, etc. Fertile.

CLADONIA CORNUTA (L.) Schaer. New Brunswick: Dalhousie, on rotten stump of an *Abies*. Sterile.

CLADONIA VERTICILLATA Hoffm. New Brunswick: Dalhousie, on ground. Sterile.

CLADONIA DEGENERANS (Flk.) Spreng. British Columbia: Valemount, on an *Arctostaphylos* heath. Fertile.

CLADONIA SUBCERVICORNIS (Vain.) DR. f. TURGESCENS Magn. (Lich. Sel. Scand. Exs. II, No. 34. 1929). British Columbia: Kamloops, on a desert. Fertile.

CLADONIA PYXIDATA (L.) Fr. var. NEGLECTA (Flk.) Mass. British Columbia: Kamloops, on edge of desert. Sterile.

CLADONIA CHLOROPHAEA (Flk.) Spreng. British Columbia: Kamloops, on ground in desert; Alberta: Wainwright, in desert. Sterile.

CLADONIA FIMBRIATA (L.) Fr. var. SIMPLEX (Weis) Vain. f. MINOR (Hag.) Vain. New Brunswick: Dalhousie, at base of *Picea;* British Columbia: Kamloops, in desert. Sterile.

CLADONIA FIMBRIATA var. SIMPLEX f. MAJOR (Hag.) Vain. British Columbia: Aleza Lake, on *Picea* base. Sterile.

CLADONIA FIMBRIATA var. APOLEPTA (Ach.) Vain. New Brunswick: Dalhousie, on a very rotten rail fence. Fertile.

BACIDIA MINUSCULA Anzi var. BECKHAUSII (Körb.) Vain. Thallus obsoletus. Apothecia minutissima, 0.2–0.3 mm. lata, globosa, tuberculata, nigra, tenuiter pruinosa. Sporae juvenes, 12–18 × 2 μ, 1- to 3-septatae, bacillariae, incoloratae. Hymenium obscure olivaceum, I+ caerulescens, deinde sordide rubescens, 40 μ crassum. Epithecium K+ violascens. Hypothecium pallidum.—British Columbia: Aleza Lake, on bark of *Abies* with *Biatora helvola* and *Opegrapha* sp.

BACIDIA FUSCORUBELLA (Hoffm.) Arn. British Columbia: Aleza Lake, on trunk of a *Picea.* Fertile.

PSORA DECIPIENS (Ehrh.) Körb. British Columbia: Field (regio subalpina), on sandy ground. Fertile.

CATILLARIA TRICOLOR (With.) Th. Fr. British Columbia: Aleza Lake, occasional on twigs of *Pinus Murrayana.* Fertile.

BIATORA SYMMICTERA (Nyl.) Räs. New Brunswick: Dalhousie, on trunks and branches of *Thuja, Abies,* and *Sorbus.* Fertile.

BIATORA HELVOLA (Körb.) Th. Fr. British Columbia: Aleza Lake, on bark of *Abies.* Fertile.

LECIDEA GONIOPHILA Flk. U. S. A.: Cody, Wyoming, on sandstone in light in a cactus desert. Fertile.

LECIDEA LAPICIDA (Ach.) Vain. var. SERIATA Th. Fr. U. S. A.: Cody, Wyoming, in same situation as previous species. Fertile.

MYCOBLASTUS MELINUS (Krmplhbr.) Hellb. Thallus albido-cinereus, verruculosus, esorediatus, K+ lutescens. Apothecia nigra, opaca, 0.5–1.5 mm. lata, convexa, immarginata. Sporae binae, hyalinae, ellipsoideae, 46–55 × 25–32 μ. Hypothecium pallidum.—British Columbia: Aleza Lake, on barkless, dry, decorticated twigs of *Picea.*

MYCOBLASTUS SANGUINARIUS (L.) Norm. Thallus viridi-albidus, K−, intus sanguineus. Apothecia nigra, nitida. Sporae 46–61 × 25–31 μ, solitariae. Hypothecium crasse sanguineum.—British Columbia: Aleza Lake, on *Betula* and *Abies* trunks. Fertile.

MYCOBLASTUS SANGUINARIUS var. **Dodgeanus**[1] Räs., var. nov. Thallus albidus, verruculoso-inaequalis, esorediatus, tenuis vel mediocris, K+ auratus, Cl−, I−, intus albidus. Apothecia 1 mm. lata, atra, convexa, opaca, immarginata. Hypothecium tenuiter sanguineum vel pallido-flavescens. Sporae solitariae, magnae, oblongo-ellipsoideae, 85–92 × 26–36 μ.—British Columbia: Aleza Lake, common on bark of *Abies lasiocarpa;* Prince George and Six Mile Lake, on *Betula.*

[1] In honor of Dr. C. W. Dodge.

Acarospora Schleicheri (Ach.) Mass. British Columbia: Kamloops, on sandy ground in a desert. Fertile.

Acarospora molybdina (Wnbg.) Trevis. U. S. A.: Cody, Wyoming, on sandstone in cactus desert. Fertile.

Acarospora peltasticta Zahlbr. U. S. A.: Cody, Wyoming, with previous species on exposed sandstone in cactus desert. Fertile.

Diploschistes bryophiloides (Nyl.) Zahlbr. Alberta: Wainwright, on ground over mosses and plant remains. Fertile.

Diploschistes **canadensis** Räs., n. sp. Thallus griseo-cinereus, areolata-verruculosus, mediocris, K‡ violaceo-rubescens vel atropurpureus, Cl =, K(Cl) haud roseus, I =. Apothecia 0.5–1 mm. lata, urceolata, atra, haud pruinosa, marginata; margo crenata. Sporae 4 : nae, fuscae vel demum nigrae, muriformes, 19.5–27.5 × 11–13 μ. Hymenium I+ fulvescens. Sicut *D. scruposus* var. *terrestris* sed thallus cum KOH rubescens.—British Columbia: Kamloops, on sandy ground in desert.

Graphis scripta (L.) Ach. New Brunswick: Dalhousie, on *Abies* trunks; British Columbia: Aleza Lake, on *Abies lasiocarpa*. Fertile.

Sphaerophorus globosus (Huds.) Vain. var. lacunosus Tuck. Thallus 7 cm. altus, bene ramosus, pallido- vel olivaceo-fuscus, K =, Cl =, K(Cl) =, I∓ distincte caerulescens. Rami lacunoso-foveolati. Apothecia globosa, subterminalia.—British Columbia: Hazleton, on ground. Fertile.

Sphaerophorus **Tuckermanii** Räs., n. sp. Thallus 5–8 cm. altus, parce ramosus, albidus vel olivaceo-albidus, passim albido-roseus, K –, Cl –, K(Cl) –, I∓ dilute caerulescens, cum ramis primariis, cylindricis, 0.5–1 mm. latis, laevibus et cum ramulis adventiciis, 1–5 mm. longis, sat tenuibus et parcis. Apothecia vulgaria, terminalia, globosa, 1–2 mm. lata. Massa sporalia, nigra. Sporae 8 : nae, sphaeroideae, 5–8 μ, viridi-atrae vel fusco-nigrae. Asci anguste cylindrici.—British Columbia: Hazleton, with previous species on ground between mosses and plant remains.

Staurothele circinata Tuck. Thallus fusco-niger, areolato-diffractus, ad marginem subradiatus. Apothecia concoloria. Sporae fuscae, binae, murales, oblongo-ellipsoideae, 39–52 × 21–25 μ. Gonidia hymenialia, oblongia, viridia, 8–9.2 × 4 μ.—U. S. A.: Cody, Wyoming, on sandstone with *Acarospora molybdina* and *Squamaria alphoplaca* in a cactus desert.

Index to Genera

ASTRANTHIUM AND RELATED GENERA

ESTHER LOUISE LARSEN

Formerly Assistant Professor of Botany, University of Montana
Formerly Jessie R. Barr Fellow in Botany, Washington University

Monographic studies of *Aphanostephus* and *Achaetogeron* have made it necessary to investigate some of the related genera, particularly as to the value of certain morphological characters which are used in generic differentiation. The genera are quite similar in habit but the pappus, which furnishes important diagnostic characters, varies greatly within the group and is on the whole inconspicuous. For this reason it is necessary to make microscopic studies of the minute achenial and pappus characters upon which the differentiation of genera is primarily dependent. In this connection it was desirable to study *Astranthium* and *Keerlia* in detail; and it seems advisable to put on record the results which have been obtained relative to these genera.

Astranthium, a genus of the Compositae belonging to the tribe Astereae, was described by Nuttall in 1841.[1] It contained but one species, *A. integrifolium*, based on *Bellis integrifolia* Michaux.[2] The 'Flora of North America,' published by Torrey and Gray in 1842, relegated *Astranthium* to synonymy. Since that time American and Mexican species have been merged with the genus *Bellis*[3] which is indigenous to the Old World and especially to Europe. Three South American species have been described by Vellozo[4] as occurring in Brazil. Two of these, *Bellis campestris* Vell. and *B. pedunculata* Vell., may well be members of the genus *Spilanthes*. The relationship of the third, *Bellis scandens* Vell., is unknown to me.

Bellis perennis L. is an attractive plant, and for this reason it has been cultivated in the north Atlantic states where it has become naturalized. The American species which have been referred hitherto to the genus *Bellis* are so strikingly different that it seems strange the two generic elements should have been regarded

[1] Nutt. Trans. Am. Phil. Soc. N. S. **7**: 312. 1841.
[2] Michx. Fl. Bor. Am. **2**: 131. 1803.
[3] Torr. & Gray, Fl. N. Am. **2**: 189. 1842.
[4] Vell. Fl. Flum. **8**: *pl. 124–126*. 1827; text, pp. 338, 359, ed. 1881.

Issued April 29, 1933.

for such a long time as congeneric. The range of *Bellis* in North America is far to the north of *Astranthium integrifolium* (Michx.) Nutt., whose northernmost limit of distribution is in Kentucky. *Bellis perennis* L., on the other hand, is reported from the islands of St. Pierre and Miquelon, off the coast of Newfoundland, south to Pennsylvania, and in northwestern America north to Vancouver Island. Because of the difference in morphological characters it seems advisable to recognize *Astranthium* as a distinct genus.

Six Mexican species have been described under *Bellis*, all of which are here transferred to *Astranthium*, except *B. Garciae* Blake. The first Mexican species was described by Gray in 1852 as *Bellis mexicana*,[5] and in 1881 he transferred *Brachycome xanthocomoides*[6] to that genus. Since then four additional species have been published, namely, *B. purpurascens* Rob.,[7] *B. orthopoda* Rob. & Fern.,[8] *B. mima*, and *B. Garciae* of Blake.[9] Another species is added to this group by the transfer of *Keerlia mexicana* Gray ex Wats.[10] to *Astranthium* where it receives the new name *Astranthium xylopodum* Larsen, because of the earlier *Bellis mexicana* Gray.

Only one species, *Astranthium integrifolium*, occurs in the United States. In 1836 Rafinesque described three species, *Bellis parvifolia*, *Bellis nutans*, and *Bellis ciliata*.[11] The first two are considered synonymous with *Astranthium integrifolium* and the last is regarded as a variety of that species.

The genus *Keerlia*, which is closely related to *Astranthium*, was first described by De Candolle[12] in 1836. It contained three species, *K. linearifolia*, *K. ramosa*, and *K. skirrhobasis*. All three species have been transferred to other genera since that time. *Keerlia linearifolia*, which would ordinarily be interpreted as the generic type, was based on two distinct plants, one collected by Alaman and the other by Schiede. The former was referred to the genus *Xanthocephalum* by Dr. J. M. Greenman who pub-

[5] Gray, Smiths. Contr. [Pl. Wright. pt. 1] **3**: 93. 1852.
[6] Gray in Hemsl. Biol. Cent.-Am. Bot. **2**: 118. 1881.
[7] Rob. Proc. Am. Acad. **27**: 172. 1892.
[8] Rob. & Fern. Proc. Am. Acad. **30**: 117. 1894.
[9] Blake, Contr. U. S. Nat. Herb. **22**: 593. 1924.
[10] Gray ex Wats. Proc. Am. Acad. **22**: 422. 1887.
[11] Raf. New Fl. Am. **2**: 23. 1836.
[12] D. C. Prodr. **5**: 309. 1836.

lished the new combination *Xanthocephalum linearifolium* (DC). Greenm.[13] The latter, namely, the Schiede plant, on which *Brachycome xanthocomoides* was based and cited in synonymy by De Candolle, was transferred by Hemsley to the genus *Bellis* and published as *Bellis xanthocomoides* Gray ex Hemsley.[14] *Keerlia ramosa*[15] and *Keerlia skirrhobasis*[16] have both been transferred by Gray to the genus *Aphanostephus*.

Since the original publication of the genus by De Candolle the following species have been described: *Keerlia bellidifolia* Gray & Engelm.,[17] *Keerlia effusa* Gray,[18] and *Keerlia mexicana* Gray ex Wats.[19] Of these three species only the first two are retained in *Keerlia*, the third is transferred to *Astranthium*. Although all of the species originally described by De Candolle in *Keerlia* have been excluded from that genus, nevertheless it seems advisable to use *Keerlia* as the generic name for the residue, namely, for those species which have been described subsequently and still remain in that genus. The historical name is thus retained; and the genus is delimited in accordance with Gray's treatment in the 'Synoptical Flora of North America'.[20] Moreover, the name *Bourdonia*, proposed by Greene,[21] falls to synonymy.

General Morphology

The American genus *Astranthium* is morphologically distinct from *Bellis* of the Old World with which it was merged in 1842. In habit the genera are quite different. *Bellis* produces long naked monocephalous peduncles from rosulate clusters of basal leaves, whereas the stems of *Astranthium* are usually branched and seldom entirely naked.

The involucre of *Astranthium* is composed of two or three series of bracts which are usually membranaceous margined.

[13] Greenm. Field Mus. Nat. Hist. Publ. Bot. Ser. **2**: 345. 1912.
[14] Gray in Hemsl. Biol. Cent.-Am. Bot. **2**: 118. 1881.
[15] Gray, Proc. Am. Acad. **16**: 81. 1881.
[16] Gray, Smiths. Contr. [Pl. Wright. pt. 1] **3**: 93. 1852.
[17] Gray & Engelm. Proc. Am. Acad. **1**: 47. 1848.
[18] Gray, Bost. Jour. Nat. Hist. [Pl. Lindh. pt. 2] **6**: 222. 1850.
[19] Gray, Proc. Am. Acad. **22**: 422. 1887.
[20] Gray, Syn. Fl. N. Am. **1**[2]: 164. ed. 2, 1886 and 1888.
[21] Greene, Erythea **1**: 207. 1893.

The involucral bracts of *Bellis* differ in that they are subuniseriate, more or less united at the base, and distinctly foliaceous throughout. On the whole they are broader than those of *Astranthium* and less acute.

A marked contrast between the two genera is to be found in the receptacle. In *Astranthium* it is a low, convex, cushion-like structure with alveolate surface of a light creamy or whitish color. The receptacle of *Bellis* is distinctly conical. It has a smooth, almost shiny, dark greenish-brown surface which is broken only by the white spots indicating points of achenial attachment, and by depressions which are due to shriveling of the subepidermal tissue (pl. 2, figs. 1 and 7).

The corollas of the disk- and ray-flowers are very similar in these genera. The ray-flowers of *Astranthium* may be said to be proportionately longer than those of *Bellis*. The stamens in both cases are typically asteroid (pl. 2, figs. 2, 3, 4, 8, 9, 10).

The achenes of the genera are similar in outline and size. *Bellis* has achenes with distinct margins, while those of *Astranthium* are without distinct margins and are usually more or less pubescent with glochidiate-tipped hairs.

The pistils are similar in size but differ in the characters of their style-branches. *Astranthium* has long, slender, acute style-branches in contrast to those of *Bellis*, which are only about one-half as long as broad, thick, and obtuse (pl. 2, figs. 5, 6, 11, 12).

The pappus is entirely lacking in *Bellis* and this is also the most usual condition in *Astranthium*. There are, however, certain exceptions. *Astranthium xanthocomoides* has a slight indication of a ring-like crown. The ring-like crown is more noticeable in *A. orthopodum* and becomes conspicuous in *A. mexicanum* var. *chihuahuense* where it is somewhat fluted. This vestigial pappus when present forms an unbroken ring-like crown which is entirely without lacerate margins commonly found in related genera.

Geographical Distribution

The only representative of the genus *Astranthium* occurring in the United States is *Astranthium integrifolium* with its two varieties *ciliatum* and *rosulatum*. The species extends from

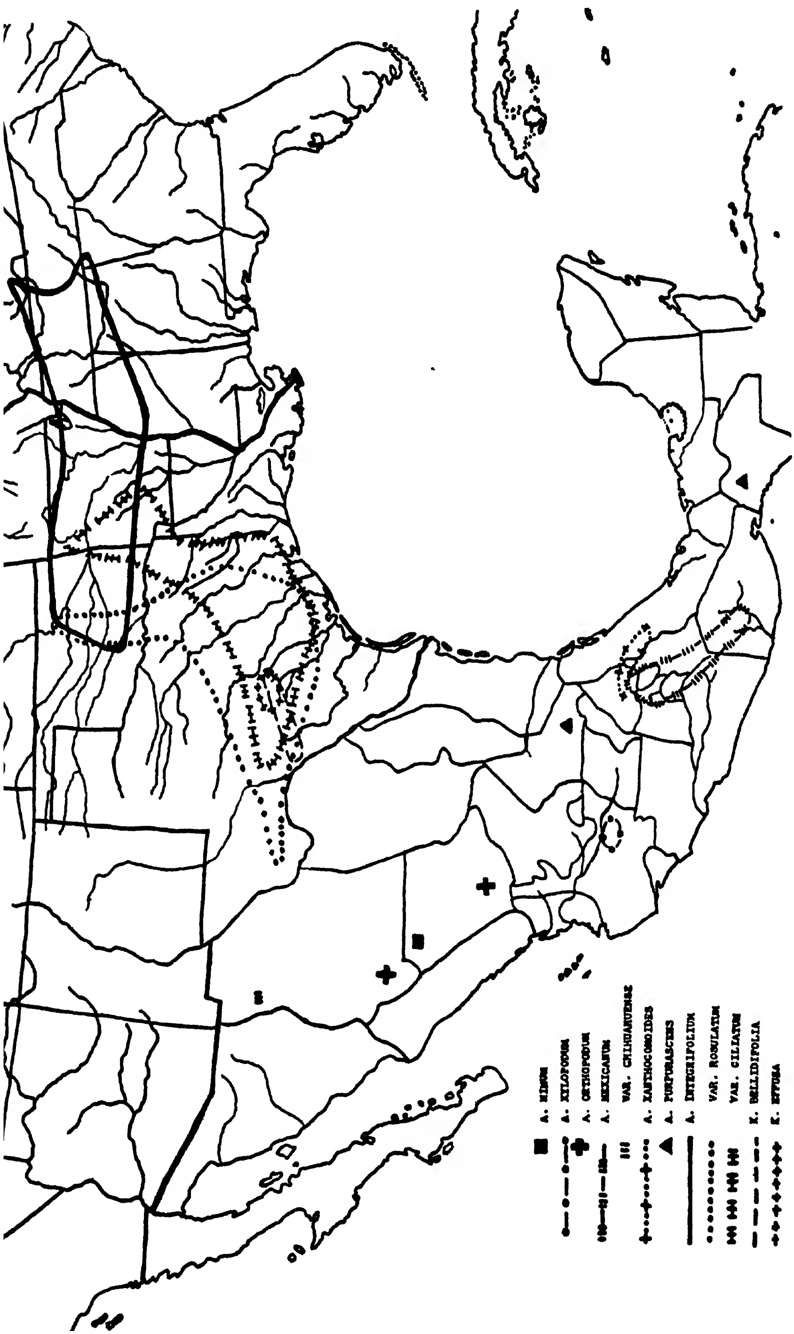


Fig. 1. Geographical distribution of *Astranthium* and *Keerlia*.

After the cut of the map had been made material was found which extends the range of two of the species. A specimen of *Astranthium integrifolium* from Chautauqus Co., Kansas, extends the range of the species northwestward into that state. *Keerlia bellidifolia* has been

Georgia and Kentucky to western Oklahoma and Kansas. The varieties occur in Oklahoma, Arkansas, and Texas.

Mexican representatives of *Astranthium* are scattered throughout Mexico from Chihuahua to Chiapas. There is very little material in American herbaria representing Mexican species. *Astranthium mimum* is known only from the locality in which it was collected originally. *Astranthium purpurascens* was found by C. G. Pringle in San Luis Potosi, but the same species was also collected previously by Dr. A. Ghiesbreght in Chiapas. *Astranthium xylopodum* is reported only from eastern Jalisco where it has been collected by both Dr. Edward Palmer and C. G. Pringle. *Astranthium orthopodum* occurs in the mountains of Chihuahua and in Durango. The oldest Mexican species and the one which is best represented in herbaria is *A. mexicanum.* It extends from Hidalgo to central Oaxaca; and a variety, *chihuahuense*, occurs in northwestern Chihuahua. *Astranthium xanthocomoides* has been reported from Hidalgo and Vera Cruz.

The scattered distribution of *Astranthium* in Mexico is probably an indication of the incomplete representation of the flora of that country in herbaria. Further collections will undoubtedly extend the distribution areas and also add to the number of species.

Two species of the genus *Keerlia* are recognized and both of these occur in south-central Texas. It is not at all unlikely that they will be found in adjacent Mexico. The distribution of the various species representing *Astranthium* and *Keerlia* is shown on the accompanying map.

Acknowledgments

The writer wishes to express her appreciation to Dr. George T. Moore, Director of the Missouri Botanical Garden, for the use of the library and herbarium of that institution, and especially to Dr. J. M. Greenman for advice and assistance. Dr. B. L. Robinson and Dr. W. R. Maxon kindly loaned material which was necessary to the study of these genera.

Abbreviations

The specimens cited in this paper are deposited in the herbaria which are indicated by the following abbreviations:

G = Gray Herbarium of Harvard University.
M = Missouri Botanical Garden Herbarium.
US = United States National Herbarium.

Key to the Genera

A. Heads small, few-flowered.......................................*Keerlia*
AA. Heads medium-sized, many-flowered.
  a. Achenes strongly compressed, not 4-angled.
    b. Heads subglobose; rays relatively short..........................*Egletes*
    bb. Heads not subglobose; rays relatively long.
      c. Pappus absent or of a ring-like crown; ray-flowers uniseriate.
        d. Receptacle smooth, conical; involucral bracts sub-uniseriate...*Bellis*
        dd. Receptacle alveolate, convex; involucral bracts bi-tri-seriate. ....*Astranthium*
      cc. Pappus of a short unequally lacerated crown; ray-flowers in 2 or more series..*Achaetogeron*
  aa. Achenes not compressed, subterete, or distinctly 4–5-angled....*Aphanostephus*

Key to Species of Astranthium

A. Stems erect or suberect from a distinctly ligneous base.
  a. Leaves glabrous.......................................*1. A. mimum*
  aa. Leaves more or less pubescent.
    b. Stems usually unbranched above.
      c. Leaves oblong-elliptic..............................*2. A. xylopodum*
      cc. Leaves oblanceolate to linear.........................*3. A. orthopodum*
    bb. Stems usually branched above.
      c. Leaves dentate....................................*4. A. mexicanum*
      cc. Leaves entire.................................*4a.* Var. *chihuahuense*
AA. Stems erect or procumbent from an annual or slightly ligneous base.
  a. Plants with long slender runners......................*5. A. xanthocomoides*
  aa. Plants without long slender runners.
    b. Achenes glabrous..................................*6. A. purpurascens*
    bb. Achenes pubescent with glochidiate-tipped hairs.
      c. Leaves not rosulate.
        d. Plants not conspicuously branched................*7. A. integrifolium*
        dd. Plants conspicuously branched...................*7a.* Var. *ciliatum*
      cc. Leaves rosulate..................................*7b.* Var. *rosulatum*

Taxonomy

ASTRANTHIUM

Astranthium Nutt. Trans. Am. Phil. Soc. N. S. **7**: 312. 1841; Benth. & Hook. Gen. Pl. **2**: 265. 1873, as to synonymy.

Bellis Michx. and Am. authors, Fl. Bor. Am. **2**: 131. 1803, not of Linnaeus; Hook. Bot. Mag. **52**: *pl. 3455.* 1835; DC. Prodr. **5**: 304. 1836; Raf. New Fl. Am. **2**: 24. 1836; Torr. &

Gray, Fl. N. Am. **2**: 189. 1842; Gray in Hemsl. Biol. Cent.-Am. Bot. **2**: 118. 1881; Gray, Syn. Fl. N. Am. **1**^{2}: 163. 1884, and ed. 2, 163. 1886 and 1888; Britton & Brown, Ill. Fl. **3**: 350. 1898, and ed. 2, **3**: 402. 1913; Britton, Manual, 943. 1901, and ed. 2, 1905; Rob. & Fern. in Gray, Manual, ed. 7, 799. 1908; Small, Fl. Southeastern U. S. 1202. 1903, and ed. 2, 1913.

Herbaceous, caulescent, glabrate, or pubescent annuals or perennials. Leaves alternate, sessile or petioled, linear-lanceolate to obovate-spathulate, entire or dentate. Involucre 2–3-seriate, imbricated, appressed, lanceolate bracts usually with lacerately ciliate, membranaceous margins. Heads few- to many-flowered. Ray-flowers pistillate, rays 2–3-dentate. Disk-flowers tubular, perfect, corolla 5-lobed. Style-branches linear-lanceolate, acute, papillose at the tip, stigmatic surfaces confined to the lowermost margins of the style-branches and extending one third of their length. Pappus entirely lacking or an inconspicuous ring-like crown. Achenes obovate, compressed, narrowed at the base, pubescent with glochidiate or emarginate hairs, rarely glabrous.

Type species: *Astranthium integrifolium* (Michx.) Nutt. Trans. Am. Phil. Soc. N. S. **7**: 312. 1841, which was based on *Bellis integrifolia* Michx. Fl. Bor. Am. **2**: 131. 1803, "ad ripas rivulorum et in collibus umbrosis Tennassée."

1. **Astranthium mimum** (Blake) Larsen, n. comb.

Bellis mima Blake, Contr. U. S. Nat. Herb. **22**: 594. 1924.

Herbaceous perennial, 38–50 cm. high; stems several, simple, erect, monocephalous, greenish, striate, glabrous or sparsely pubescent with spreading hairs; basal leaves few, obovate-oblong, apiculate, narrowed at the base into a slender petiole, 15–20 cm. long, 2–3 cm. wide, somewhat membranous in the dried state; stem-leaves linear-lanceolate, hirsute-ciliate, lower 5–6 cm. long, 4–6 mm. wide, gradually reduced above, the uppermost 1 cm. long, 1 mm. wide; peduncles terminal, monocephalous, enlarged just below the head; involucre 2–2.5 cm. in diameter; bracts 2-seriate, equal, 7 mm. high, linear, acute, sparsely pilose, ciliate; ray-flowers about 60, white, fertile, 3-dentate, about 12 mm. long; disk-flowers yellow, fertile, pappus

none; achenes of ray and disk similar, oblong, compressed, glabrous.

Distribution: State of Durango, Mexico. Known only from type specimen.

Specimens examined:

DURANGO: from Sierra Madre, 30 miles north of Guanacevi, alt. 2440–2745 m., Aug. 18, 1898, *Nelson 4786* (US, No. 332836, TYPE).

2. **Astranthium xylopodum** Larsen, n. name.

Keerlia mexicana Gray, Proc. Am. Acad. **22**: 422. 1887, not *Bellis mexicana* Gray, Smiths. Contr. [Pl. Wright. pt. 1] **3**: 93. 1852.

Perennial from a woody base; stems several, simple, or slightly branched near the top, striate, hirsute with spreading pubescence; peduncles 10–14 cm. long, naked or bearing 1–2 small linear-lanceolate bracts near the inflorescence, hirsute-pubescent; leaves oblong-elliptic, evenly pubescent with appressed hirsute hairs, margins strongly ciliate; involucre 1–2 cm. in diameter; bracts linear-lanceolate, pubescent, margins lacerately ciliate, somewhat membranaceous; ray-flowers fertile, about 20; pappus lacking; achenes 4-nerved, glabrous.

Distribution: known only from the State of Jalisco, Mexico.

Specimens examined:

JALISCO: shaded hillsides near Guadalajara, June 27–July 14, 1893, *Pringle 4412* (M, G); Rio Blanco, July 1886, *Edward Palmer 146* (G, TYPE).

3. **Astranthium orthopodum** (Rob. & Fern.) Larsen, n. comb.

Bellis orthopoda Rob. & Fern. Proc. Am. Acad. **30**: 117. 1894.

Perennial from a short, thick rootstalk; stems several, decumbent or suberect, 10–20 cm. high, simple or somewhat branched, appressed-pubescent, monocephalous; leaves thick, entire, appressed-pubescent, basal leaves oblong-spathulate, 3–4 cm. long, 3–5 mm. broad, stem-leaves linear-lanceolate, erect, gradually reduced toward the inflorescence; peduncles 3–4.5 cm. long, appressed-pubescent; involucre 10–12 mm. in diameter; bracts 2-seriate, linear-lanceolate, acute, purple-margined, sparsely and somewhat appressed-pubescent, 4–5 mm. long; ray-flowers about 30, 1 cm. long; achenes sparsely pubescent with glochidiate or straight and slightly emarginate hairs; pappus an inconspicuous whitish ring-like crown.

Distribution: western Chihuahua, southward along mountains in the state of Durango, Mexico.

Specimens examined:

Chihuahua: Guachachic, June 25, 1892, *Hartman 523* (G, type); vicinity of Madera, alt. 2250 m., May 27–June 3, 1908, *Edward Palmer 287* (M).

Durango: City of Durango and vicinity, Apr.–Nov. 1896, *Edward Palmer 163* (M); Otinapa, July 25–Aug. 5, 1906, *Edward Palmer 425* (M).

4. **Astranthium mexicanum** (Gray) Larsen, n. comb.

Bellis mexicana Gray, Smiths. Contr. [Pl. Wright. pt. 1] **3**: 93. 1852; Gray in Hemsl. Biol. Cent.-Am. Bot. **2**: 118. 1881.

Perennial from a branched ligneous base; stems 15–60 cm. high, several, branched above, striate, pubescent with spreading hairs; leaves appressed-pubescent, those of the stem sessile, entire, or saliently dentate, oblong-linear, gradually reduced toward the inflorescence, basal leaves ellipsoid-spathulate, crenate-dentate, 5–20 cm. long, .8–2.5 cm. broad; involucre .8–1.4 cm. in diameter; bracts 2–3-seriate, cinereous-pubescent, linear-lanceolate, purple-tipped; ray-flowers white, numerous, .5–1.0 cm. long; pappus an inconspicuous ring-like crown or almost obsolete; achenes compressed, pubescent.

Distribution: mountains of south-central Mexico.

Specimens examined:

Hidalgo: Sierra de Pachuca, alt. 3076 m., Aug. 26, 1902, *Pringle 9857* (M).

Mexico: Apr. 26, 1849, *Gregg 701* (M, type); along brooks, Ixtaccihuatl, March–July 1903, *Purpus 159* (M); moist open woods and meadows about timber line, Ixtaccihuatl, Oct. 1905, *Purpus 1575* (M); "above timber line," Popocatepetl, Oct. 1908, *Purpus 3640* (M).

Federal District: Cima, Aug. 24, 1910, *Orcutt 3768* (M); Serrania de Ajusco, alt. 3076 m., Aug. 8, 1896, *Pringle 6442* (M).

Morelos: Toro, alt. 3015 m., Aug. 5, 1924, *Fisher* (M, No. 914805).

Oaxaca: Sierra de San Felipe, alt. 3076 m., June 28, 1894, *Pringle 4719* (M); Sierra de San Felipe, alt. 3076 m., Sept. 1894, *Smith 261* (M).

4a. Var. **chihuahuense** Larsen, n. var.[22] Plate 3.

Resembles the species in habit but differs from it in that it is much less pubescent; the leaf margins are essentially entire, ciliate; the pappus is more conspicuous than that of the species and consists of a narrow fluted crown; the achenes are glabrous, or glabrate.

[22] **Astranthium mexicanum** (Gray) Larsen var. **chihuahuense** Larsen, n. var., planta herbacea perennis, 6–7 dm. alta, supra ramosa; marginibus foliorum integris vel subintegris; pappo coroniforme, margine irregulariter sinuato-dentato; achaeniis glabris vel glabratis.—Mexico: canyons of Sierra Madre, State of Chihuahua, Oct. 4, 1888, *Pringle 2015* (M, No. 122921, type).

Distribution: State of Chihuahua, Mexico, known only from the type.
Specimens examined:
CHIHUAHUA: canyons of Sierra Madre, Oct. 4, 1888, *Pringle 2015* (M, No. 122921, TYPE).

5. **Astranthium xanthocomoides** (Less.) Larsen, n. comb.

Brachycome xanthocomoides Less. Syn. 192. 1832, nomen subnudum; Schlecht. in Linnaea 9: 265. 1835.

Brachycome xeranthemoides Steud. Nomencl. Bot. ed. 2, 220. 1840, in part (typographical error).

Keerlia linearifolia DC. Prodr. 5: 310. 1836, in part as to synon.

Bellis xanthocomoides (Less.) Gray in Hemsl. Biol. Cent.-Am. Bot. 2: 118. 1881.

Annual; stems several, striate, procumbent or ascending, branching, leafy throughout, producing slender runners; leaves spathulate, apiculate, sparsely pubescent, gradually reduced toward the peduncles, 1.5–2.5 cm. long, .3–.8 cm. broad; peduncles 1–6 cm. long, densely pubescent at the base of the involucre; involucre .8–1.2 cm. in diameter; bracts 2-seriate, lanceolate, acute, pubescent along the lower portion of the main axis, membranaceous-margined; ray-flowers white, .5–.8 cm. long, about 16; pappus practically lacking; achenes compressed, pubescent, becoming more or less glabrate.

Distribution: alpine meadows and open woods of east-central Mexico.
Specimens examined:
VERA CRUZ: prope la Jaya (La Hoya), June 29, *Schiede 206* (M, TYPE).
HIDALGO: meadows of Sierra de Pachuca, alt. 2760 m., July 17–28, 1898, *Pringle 6888* (M); alpine meadows, Sierra de Pachuca, alt. 2923 m., Aug. 26, 1902, *Pringle 9858* (M); moist meadows and open woods, Pachuca, July 1905, *Purpus 1344* (M).

6. **Astranthium purpurascens** (Rob.) Larsen, n. comb.

Bellis purpurascens Rob. Proc. Am. Acad. 27: 172. 1892.

Perennial; roots of numerous fibers; stems erect, branched, 4–45 cm. high, striate, pubescent with spreading hairs; leaves apiculate, pubescent with spreading hairs, margins somewhat ciliate; lower leaves oblong-ovate, 2.5–4.0 cm. long, 1.5–6 cm. broad; upper leaves linear to linear-lanceolate, gradually reduced, 1 cm. or less in length at the base of the peduncles; peduncles 3–8 cm. long; involucre .8–1.0 cm. in diameter; involucral bracts about 14–16, lanceolate, acute, scarious-margined, only slightly

ciliate near the apex, pubescent along the main axis with a few upwardly appressed hairs; rays 10–15, whitish-purple, .5–.8 cm. long; pappus lacking; achenes glabrous, golden-brown at maturity.

This species is closely allied to *A. integrifolium* (Michx.) Nutt.; the chief difference is to be found in achenial characters. *Astranthium integrifolium* has achenes which are pubescent with glochidiate-tipped hairs whereas *A. purpurascens* (Rob.) Larsen has glabrous achenes.

Distribution: known only from the type locality and Chiapas, Mexico.

Specimens examined:

San Luis Potosi: shaded grassy slopes, barranca of Las Canoas, Aug. 18, 1891, *Pringle 3819* (M, cotype).

Chiapas: without definite locality, coll. of 1864–70, *Ghiesbreght 548* (M).

7. **Astranthium integrifolium** (Michx.) Nutt. Trans. Am. Phil. Soc. N. S. **7**: 312. 1841.

Bellis integrifolia Michx. Fl. Bor. Am. **2**: 131. 1803; Hook. Bot. Mag. **52**: *pl. 3455.* 1835, in part, exclusive of *Brachycome xanthocomoides* Less.; DC. Prodr. **5**: 304. 1836; Raf. New Fl. Am. **2**: 24. 1836; Torr. & Gray, Fl. N. Am. **2**: 189. 1842; Gray, Syn. Fl. N. Am. **1**^{2}: 163. 1884, and ed. 2, 1886 and 1888; Britton & Brown, Ill. Fl. **3**: 350. 1898, and ed. 2, **3**: 402. 1913; Britton, Manual, 943. 1901, and ed. 2, 1905; Rob. & Fern. in Gray, Manual, ed. 7, 799. 1908; Small, Fl. Southeastern U. S. 1202. 1903, and ed. 2, 1913.

Bellis nutans Raf. New Fl. Am. **2**: 23. 1836.

Bellis parviflora Raf. *Ibid.*

Eclipta integrifolia Spreng. Syst. Veg. **3**: 602. 1826.

Annual, openly branched from near the base, 8–45 cm. high, sparsely pubescent with spreading or subappressed hairs, frequently conspicuously pubescent near the base, leafy throughout; lower leaves oblong-spathulate, 2.5–4.0 cm. long, .8–1.4 cm. broad; stem-leaves oblong-ovate, sparsely pubescent, margins ciliate, 3.5 cm. long, 1.5 cm. broad, gradually reduced toward the base of the peduncle; peduncles 4–9 cm. long, densely pubescent at the base of the involucre; involucre 2-seriate, about .6–1.2 cm. in diameter, bracts lanceolate, acuminate, acute, membranous margins only slightly lacerate, sparsely pubescent along the main

axis with a few spreading hairs; ray-flowers fertile, 16–22, purplish-blue; achenes compressed, pubescent with glochidiate-tipped hairs.

Distribution: sandy soil, south-central Kentucky to northwestern Georgia, westward to southeastern Kansas and eastern Oklahoma.

Specimens examined:

Georgia: dry ground, Ringold Road, Chickamauga, May 27, 1911, *Churchill* (M, No. 839094).

Mississippi: Tchula, Holmes Co., Apr. 18, 1927, *Woodson & Anderson 1555* (M).

Kentucky: Bowling Green, May 6, 1892, *Price* (M, No. 122882).

Tennessee: West Nashville, May 26–27, 1909, *Eggleston 4422* (M); moist field, Joelton, Davidson Co., July 16, 1922, *Svenson 118* (G); copses around Nashville, May–June, *Gattinger 1297* (M); rocky open hillsides, near Erin, Houston Co., May 24, 1920, *E. J. Palmer 17623* (M, G).

Missouri: gravelly barrens, Noel, May 10, 1915, *Bush 7534* (M, G); gravelly barrens, Noel, May 10, 1915, *Bush 7534 A* (M); rocky open ground, near Jane, MacDonald Co., May 23, 1931, *E. J. Palmer 39297* (M); rocky slopes, bald knobs, along creek, near Oasis, Taney Co., June 3, 1931, *E. J. Palmer 39483* (M).

Arkansas: river bottoms near Fayetteville, June 1835, *Engelmann 129* [*607*] (M); alluvial soil, waste places, cultivated fields, Fayetteville, May, *Harvey 45* (M); Fayetteville, 1880, *Harvey* (M, No. 122880); Hot Springs, May, 1879, *Soulard* (M, No. 122885); sandy soil, Cotter, Marion Co., June 15, 1914, *E. J. Palmer 5992* (M).

Kansas: rocky soil, Chautauqua Co., May 7, 1897, *Hitchcock 1055* (M).

Oklahoma: in woods and meadows, common near Tishomingo, Johnston Co., Apr. 27, 1916, *Houghton 3549* (G); clay washes, near Ardmore, Carter Co., Apr. 17, 1913, *Stevens 77* (M); Arbuckle Mts., Crusher, May 12, 1916, *Emig 606* (M); Catoosa, May 8, 1895, *Bush 897* (M); Ind. Terr., 1877, *Butler* (M, No. 122886); upland prairies, sandy soil, near Howe, Le Flore Co., May 25, 1931, *E. J. Palmer 39343* (M).

7a. Var. **ciliatum** (Raf.) Larsen, n. comb. Pl. 4, fig. 1.

Bellis ciliata Raf. New. Fl. Am. 2: 24. 1836.

Bellis integrifolia Gray, Smiths. Contr. [Pl. Wright. pt. 2] 5: 78. 1853, in part.

Stems several, diffusely branched from near the base, 1–3 dm. high, terminated by long slender peduncles; leaves oblong-spathulate to linear-oblong, reduced to small bract-like leaves at the base of the peduncles, .8–3.0 cm. long, .2–.8 cm. broad, sparsely pubescent with subappressed hairs, margins ciliate; peduncles 4–6 cm. long; involucre .5–.8 cm. in diameter; involucral bracts lance-elliptic, acute, the narrow membranaceous margins lacerately ciliate; ray-flowers about 9–15; achenes pubescent with glochidiate-tipped hairs.

Distribution: from southeastern Oklahoma and southwestern Arkansas to south-central Texas, west to the Pecos.

Specimens examined:

Arkansas: moist open ground, Fayetteville, Washington Co., July 6, 1915, *E. J. Palmer 8176* (M); Coal Bank, May 14, 1895, *Bush 895* (M); Redfork, May 14, 1895, *Bush 896* (M).

Oklahoma: open woods near Idabel, McCurtain Co., May 18, 1916, *Houghton 3645* (G).

Texas: Apr.–May, 1844, *Lindheimer 251* (M); "Pine's Island," May 5, 1903, *Reverchon* (M, No. 122889); *Reverchon 440* in part (M, No. 122890); clay barrens, Bryan, Brazos Co., May 27, 1915, *E. J. Palmer 7785* (M); Pecos and Limpio, June 1851–2, *Wright 1176* in part (M, No. 123093); dry banks, Hempstead, Apr. 24, 1872, *Hall 306* (M).

7b. Var. rosulatum Larsen, n. var.[23] Pl. 4, fig. 2.

Bellis integrifolia Gray, Smiths. Contr. [Pl. Wright. pt. 2] **5**: 78. 1853, in part.

Stems several, sparsely branched near the base, pubescent with spreading hairs, .5–1.5 dm. high; leaves sparsely pubescent with subvillose hairs; basal leaves numerous, forming a rosette, oblong-spathulate, 2–7 cm. long, .5–1 cm. broad; stem-leaves oblong-spathulate to linear-lanceolate, gradually reduced to the base of the peduncle; peduncle 1.5–5 cm. long; involucre about .7 cm. in diameter; bracts lance-elliptic, acute, the narrow membranaceous margins somewhat lacerately ciliate near the apex; ray-flowers about 16; achenes densely pubescent with glochidiate-tipped hairs.

Distribution: central Oklahoma and eastern Texas west to Presidio County.

Specimens examined:

Oklahoma: open woods near Mannsville, Johnston Co., May 16, 1916, *Griffith 3455* (M, G); Limestone Gap, Apr. 16, 1877, *Butler 63* (M); Sapulpa, Apr. 28, 1895, *Bush 927* (M); "Arkansas," May 20, 1895, *Bush 929* (M).

Texas: sandy prairies, Columbia, Brazoria Co., March 25, 1914, *E. J. Palmer 5028* (M); Victoria, Victoria Co., March 5, 1916, *E. J. Palmer 9070* (M); sandy open ground, Larissa, Cherokee Co., Apr. 7, 1916, *E. J. Palmer 9388* (M); sandy prairies, Matagorda, Matagorda Co., March 5, 1914, *E. J. Palmer 4855* (M, No. 753171, type); on plains, Handley, Apr. 15, 1913, *Ruth 74* (M, G); along railroads near Houston, Apr. 23, 1899, *Eggert* (M, Nos. 122893 & 122895); Terrell, Apr. 6, 1903, *Reverchon 4006* (M); prairies near Victoria, Apr. 7 & 10, 1900, *Eggert* (M, No. 122899); Pecos and Limpio, June 1851–2, *Wright 1176* in part (M, No. 123091); near San Felipe,

[23] **Astranthium integrifolium** (Michx.) Nutt. var. **rosulatum** Larsen, n. var., caule simplice vel basi ramoso, 0.5–1.5 dm. alto, subvilloso; foliis basalibus rosulatis, oblongo-spathulatis, 2–7 cm. longis, usque ad 1 cm. latis, integris, ad apicem rotundatis vel obtusis, sparse pubescentibus; foliis caulinis oblongo-spathulatis vel lineari-lanceolatis, integris, superne sensim minoribus; pedunculis 1–6 cm. longis.—Texas: on sandy prairies, Matagorda, Matagorda County, March 5, 1914, *E. J. Palmer 4855* (M, 753171, type).

Apr. 1839, *Lindheimer* (M, No. 122904); along river, Columbia, Apr. 19, 1899, *Bush 195* (M); on prairie, Chenango Junction, Apr. 18, 1900, *Bush 60* (M); *Reverchon 440* in part (M, No. 122898); open ground, along railway grade near Marfa, Presidio Co., June 18, 1926, *E. J. Palmer 31036* (M).

KEERLIA

Keerlia Gray, Bost. Jour. Nat. Hist. [Pl. Lindh. pt. 2] **6**: 221, 222. 1850, in part as to *K. bellidifolia* and *K. effusa*, not DC.; Smiths. Contr. [Pl. Wright. pt. 1] **3**: 92. 1852, not DC.; Syn. Fl. N. Am. 1^2: 164. 1884, and ed. 2, 164. 1886 and 1888.

Bourdonia Greene, Erythea **1**: 207. 1893.

Herbaceous, caulescent, pubescent annuals or perennials. Leaves alternate, sessile or petioled, oblong to obovate-spathulate, entire. Involucre of imbricated lanceolate bracts, with membranaceous margins. Heads few-flowered. Ray-flowers in a single series, pistillate, fertile. Disk-flowers tubular, five-lobed, frequently sterile. Branches of the style lanceolate, acutish, hairy toward the tip. Pappus a thickened ring-like or slightly lacerated crown. Achenes compressed, glabrate or hirsute-pubescent.

Type species: *K. bellidifolia* Gray & Engelm. Proc. Am. Acad. **1**: 47. 1848, which was based on No. 415 of Lindheimer, collected above Guadeloupe, Texas, 1845–1846.

Key to the Species

Stems branched from the base .... *8. K. bellidifolia.*
Stems simple to the inflorescence .... *9. K. effusa*

8. Keerlia bellidifolia Gray and Engelm. Proc. Am. Acad. **1**: 47. 1848; Gray, Bost. Jour. Nat. Hist. [Pl. Lindh. pt. 2] **6**: 220. 1850; Smiths. Contr. [Pl. Wright. pt. 1] **3**: 92. 1852; Syn. Fl. N. Am. 1^2: 164. 1884, and ed. 2, 164. 1886 and 1888.

Bourdonia bellidifolia (Gray & Engelm.) Greene, Erythea **1**: 207. 1893.

Annual; the caudex giving rise to much-branched stems 9–30 cm. high, leafy throughout, striate, pubescent with multicellular spreading hairs; leaves thin, sparsely pubescent, apiculate, lower leaves obovate-spathulate, uppermost somewhat linear, gradually reduced toward the inflorescence, 1–4 cm. long, .4–1.0 cm. broad, narrowed below to a subpetiolate base; heads small; involucre

.3–.5 cm. in diameter, bracts 2–3-seriate, glabrous, linear-lanceolate, acute, with membranaceous margins; ray-flowers 4–15, blue, fertile; disk-flowers 15–20, frequently sterile, style branches shorter than those of the ray-flowers; pappus a thickened ring-like crown; achenes nerved, compressed, glabrate.

Distribution: southern Texas; doubtless also in adjacent Mexico.

Specimens examined:

Texas: along Nueces Bay, Nueces Co., alt. 6 m., March 12, 1894, *Heller 1436* (M); Rock Springs, Apr. 17, 1930, *Marcus E. Jones 26575* (M); above Guadalupe, 1845–46, *Lindheimer 415* (M, co-type); near New Braunfels, May 1848, *Lindheimer 628* (M); Comanche Spring, New Braunfels, Apr. 1850, *Lindheimer 932* (M); rocky calcareous ground, Del Rio, Valverde Co., March 26, 1917, *E. J. Palmer 11384* (M); dry limestone hills, Concan, Uvalde Co., Apr. 13, 1917, *E. J. Palmer 11550* (M); vicinity of San Antonio, Apr. 1919, *von Schrenk* (M, No. 88063); near Austin, March 17, 1908, *York 410* (M).

9. **Keerlia effusa** Gray, Bost. Jour. Nat. Hist. [Pl. Lindh. pt. 2] **6**: 222. 1850; Smiths. Contr. [Pl. Wright. pt. 1] **3**: 93. 1852; Syn. Fl. N. Am. **1**^{2}: 165. 1884, and ed. 2, 165. 1886 and 1888.

Bourdonia effusa (Gray) Greene, Erythea **1**: 207. 1893.

Perennial, 15–60 cm. high; stem simple below, diffusely branched above into an open glabrous panicle; stem and leaves hispid-pubescent; leaves thin, lowermost leaves obovate-spathulate, 3–9 cm. long, .5–1.3 cm. broad, narrowed at the base into a petiole, those of the stem oblong with a broad, sessile, somewhat amplexicaul base, gradually reduced toward the inflorescence; heads numerous, small; involucre turbinate, 2–3 cm. in diameter; involucral bracts glabrous, 3–4-seriate, linear-lanceolate, acute, membranaceous-margined; ray-flowers 4–7, white, fertile; disk-flowers 6–9, sterile; pappus consisting of a thickened irregularly lacerate crown; achenes compressed, hispid-pubescent.

Distribution: south-central Texas.

Specimens examined:

Texas: *Berlandier 499* (M); White Oak Creek, Gillespie Co., *Jermy 815* (M); shady banks of the Upper Guadalupe, 50 miles above New Braunfels, 1847–48, *Lindheimer 629* (M, co-type); dry hillside thickets, Leakey, Edwards Co., June 10, 1916, *E. J. Palmer 10165* (M); dry hillside thickets, Spanish Pass, Kendall Co., Sept. 28, 1916, *E. J. Palmer 10839* (M); San Geronimo Creek, June 1884, *Reverchon 1534* (M); Comanche Spring, New Braunfels, 1849, *Lindheimer 933* (M).

List of Exsiccatae

The distribution numbers are printed in *italics*. The number in parenthesis is the species number used in this revision.

Berlandier, J. L. *499* (9).
Bush, B. F. *897, 7534, 7534A* (7); *895, 896* (7a); *60, 195, 927, 929* (7b).
Butler, G. D.—(7); *63* (7b).
Churchill, J. R. — (7).
Eggert, H. — (7b).
Eggleston, W. W. *4422* (7).
Emig, W. H. *606* (7).
Engelmann, G. *129* [*607*] (7).
Fisher, G. L. — (4).
Gattinger, A. *1297* (7).
Ghiesbreght, A. *548* (6).
Gregg, J. *701* (4).
Griffith, F. *3455* (7b).
Hall, Elihu. *306* (7a).
Hartman, C. V. *523* (3).
Harvey, F. L. —, *45* (7).
Heller, A. A. *1436* (8).
Hitchcock, A. S. *1055* (7).
Houghton, H. W. *3549* (7); *3645* (7a).
Jermy, Gustav. *815* (9).
Jones, Marcus E. *26575* (8).
Lindheimer, F. *251* (7a); —, (7b); *415, 628, 932* (8); *629, 933* (9).
Nelson, E. W. *4786* (1).
Orcutt, C. R. *3768* (4).
Palmer, E. J. *5992, 17623, 39297, 39343, 39483* (7); *7785, 8176* (7a); *4855, 5028, 9070, 9388, 31036* (7b); *11384, 11550* (8); *10165, 10839* (9).
Palmer, Edward, *146* (2); *163, 287, 425* (3).
Price, Sadie F. — (7).
Pringle, C. G. *4412* (2); *4719, 6442, 9857* (4); *2015* (4a); *6888, 9858* (5); *3819* (6).
Purpus, C. A. *159, 1575, 3640* (4); *1344* (5).
Reverchon, J. —, *440* in part (7a); — (7b); *4006, 440* in part (7b); *1534* (9).
Ruth, Albert. *74* (7b).
Schiede, G. *206* (5).
Smith, Charles L. *261* (4).
Soulard, Mary. — (7).
Stevens, G. W. *77* (7).
Svenson, H. K. *118* (7).
von Schrenk, H. (8).
Woodson, R. E. Jr., and Anderson, E. S. *1555* (7).
Wright, Charles. *1176* in part (7a); *1176* in part (7b).
York, H. H. *410* (8).

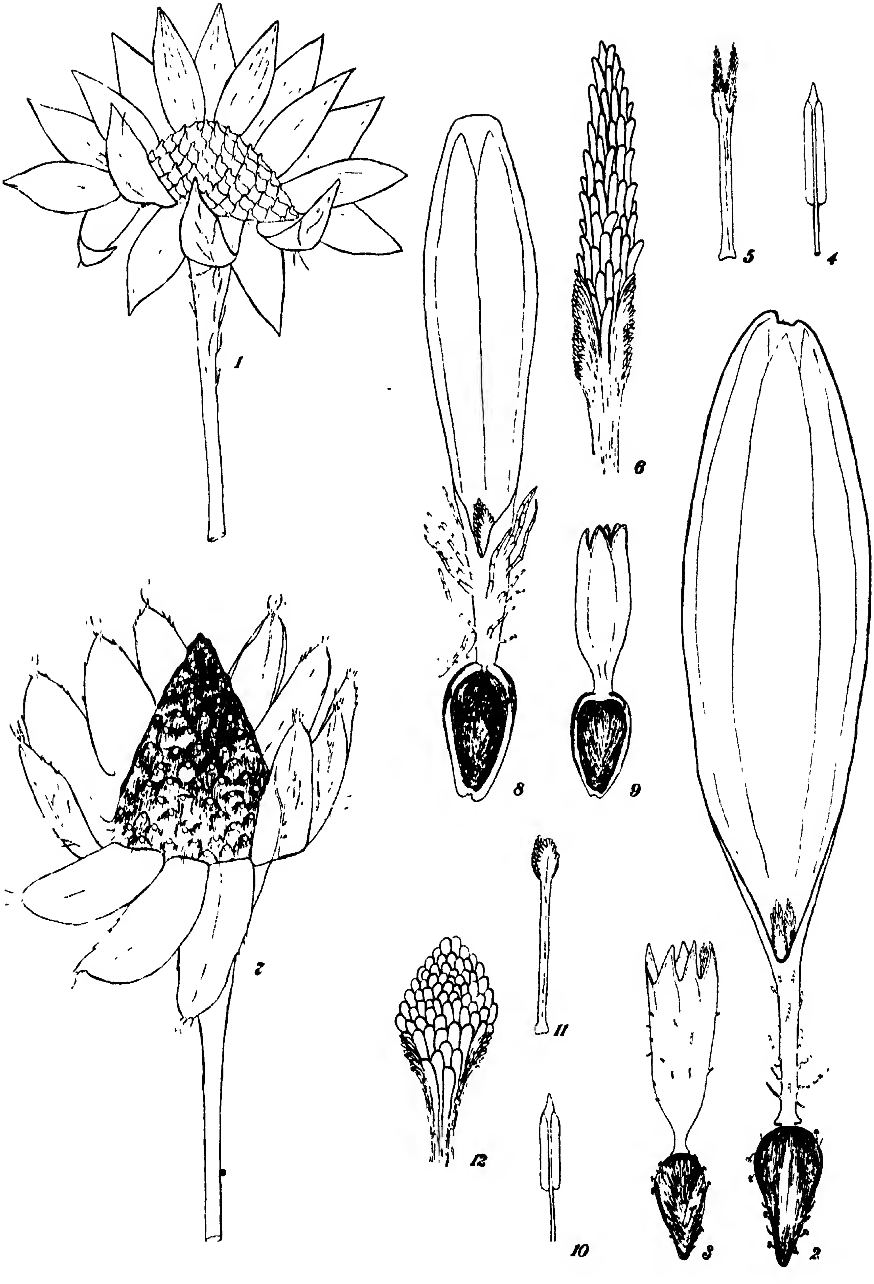
PLATE 2

Astranthium integrifolium (Michx.) Nutt. from *Eggleston 4422* in the Missouri Botanical Garden Herbarium.

Fig. 1. Involucre and receptacle, × 5.
Fig. 2. Ray-flower, × 10.
Fig. 3. Disk-flower, × 10.
Fig. 4. Stamen, × 10.
Fig. 5. Style-branches of the disk-flower, × 10.
Fig. 6. Style-branch greatly enlarged.

Bellis perennis L. from *Pring*, in the Missouri Botanical Garden Herbarium No. 918135.

Fig. 7. Involucre and receptacle, × 5
Fig. 8. Ray-flower, × 10.
Fig. 9. Disk-flower, × 10.
Fig. 10. Stamen, × 10.
Fig. 11. Style-branches of the disk-flower, × 10.
Fig. 12. Style-branch greatly enlarged.



LARSEN—ASTRANTHIUM AND RELATED GENERA

PLATE 3

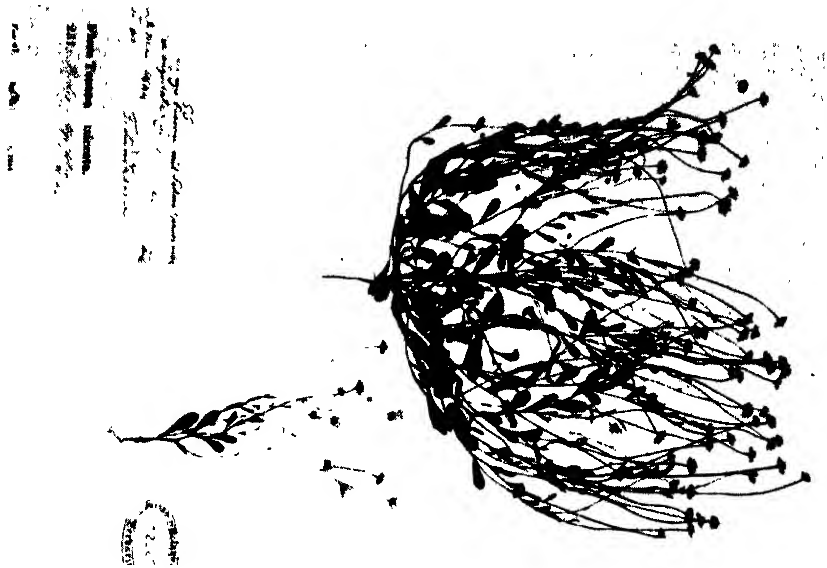
Astranthium mexicanum (Gray) Larsen var. *chihuahuense* Larsen. From the type specimen, *Pringle 2015*, in the Missouri Botanical Garden Herbarium.

LARSEN—ASTRANTHIUM AND RELATED GENERA

PLATE 4

Fig. 1. *Astranthium integrifolium* (Michx.) Nutt. var. *ciliatum* (Raf.) Larsen. From *Lindheimer 251*, in the Missouri Botanical Garden Herbarium.

Fig. 2. *Astranthium integrifolium* (Michx.) Nutt. var. *rosulatum* Larsen. From the type specimen, *Palmer 4855*, in the Missouri Botanical Garden Herbarium.



FERNS AND FERN ALLIES OF MISSOURI[1]

M. ELIZABETH PINKERTON

Assistant in Botany, Henry Shaw School of Botany of Washington University

This paper is based primarily upon material in the herbarium of the Missouri Botanical Garden, the University of Missouri, and the private collections of Mr. John H. Kellogg and of the author. After each specific name reference is given to the original publication; this is followed by reference to the two standard manuals and to an illustrated monograph covering the fern-flora of the region concerned, where the species or variety is treated under the same or a different name. These are: Gray, 'New Manual of Botany,' ed. 7, 1908; Britton and Brown, 'Illustrated Flora of the Northern States and Canada,' ed. 1, 1896, and ed. 2, 1913; and Eaton, 'Ferns of North America,' vol. 1, 1879 (*plates 1–45*) and vol. 2, 1880 (*plates 46–81*). Time of fruiting, the general distribution for North America, and the habitat for Missouri in particular precede the specific description. The names of the principal collectors whose material was examined are listed, and definite citations made when the plant is rare.

Key to Families

1. Plants with short vertical stems or rootstocks..............................2
1. Plants with horizontally spreading stems or rootstocks......................4
2. Leaves onion-like, producing sporangia at their bases...............*Isoetaceae*
2. Leaves neither onion-like nor producing sporangia at their bases...............3
3. Sporangia borne on under sides of leaves......................*Polypodiaceae*
3. Sporangia borne terminally in special fruiting clusters..........*Ophioglossaceae*
4. Sterile leaves large, usually compound or variously divided..................5
4. Sterile leaves small, often scale-like...6
5. Fertile segments leaf-like or pod-like; if the latter, sporangia covered with indusia ....*Polypodiaceae*
5. Fertile segments not leaf-like; sporangia naked................*Osmundaceae*
6. Plants truly aquatic..*Salviniaceae*
6. Plants terrestrial...7
7. Stems jointed; sporangia clustered underneath the scales of terminal cone-like spikes..*Equisetaceae*
7. Stems not jointed; sporangia borne on upper surfaces of leaves..............8

---

[1] This article is a portion only of a thesis submitted to the Board of Graduate Studies of Washington University in partial fulfillment for the requirements of the degree of master of science.

Issued April 29, 1933.

8. Spores all of the same kind. . . . .*Lycopodiaceae*
8. Spores of two kinds (larger macrospores and much smaller microspores). . . . .*Selaginellaceae*

Ophioglossaceae

1. Veins free; sporangia separate in compound inflorescences. . . . .*Botrychium*
1. Veins reticulate; sporangia disposed in a solitary spike. . . . .*Ophioglossum*

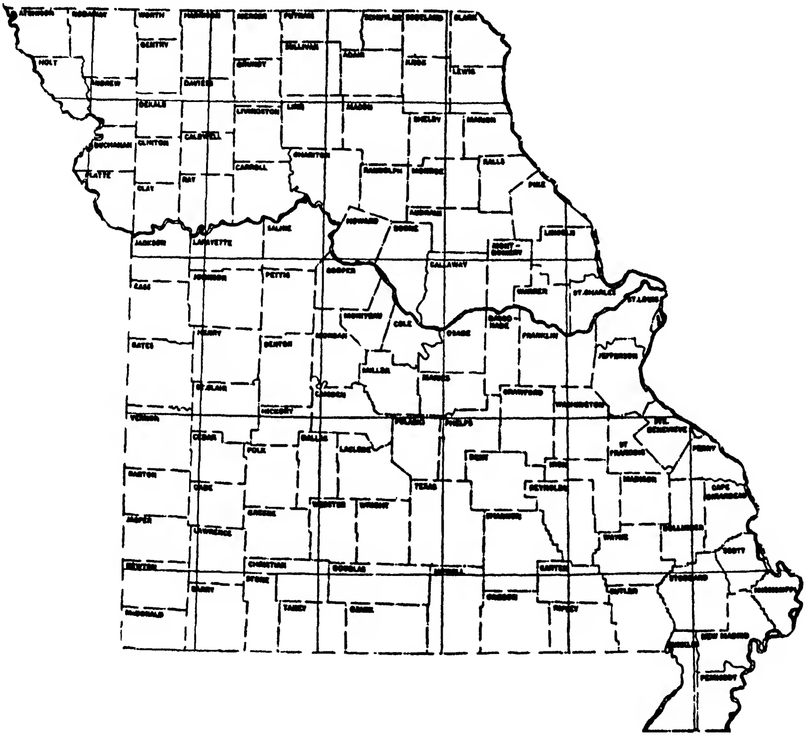


Fig. 1. Key map to distribution chart (fig. 2) showing location of counties in Missouri.

OPHIOGLOSSUM

1. Sterile segments obtuse, usually solitary; middle areoles long and narrow, outer hexagonal and containing a few included veinlets. . . . . .*1. O. vulgatum*
1. Sterile segments cuspidate, 2–5; areoles wide and containing many anastomosing veinlets. . . . .*2. O. Engelmanni*

1. **Ophioglossum vulgatum** L. Sp. Pl. 2: 1062. 1753. Gray, p. 47; Britton & Brown, ed. 1 and 2, 1: 2.

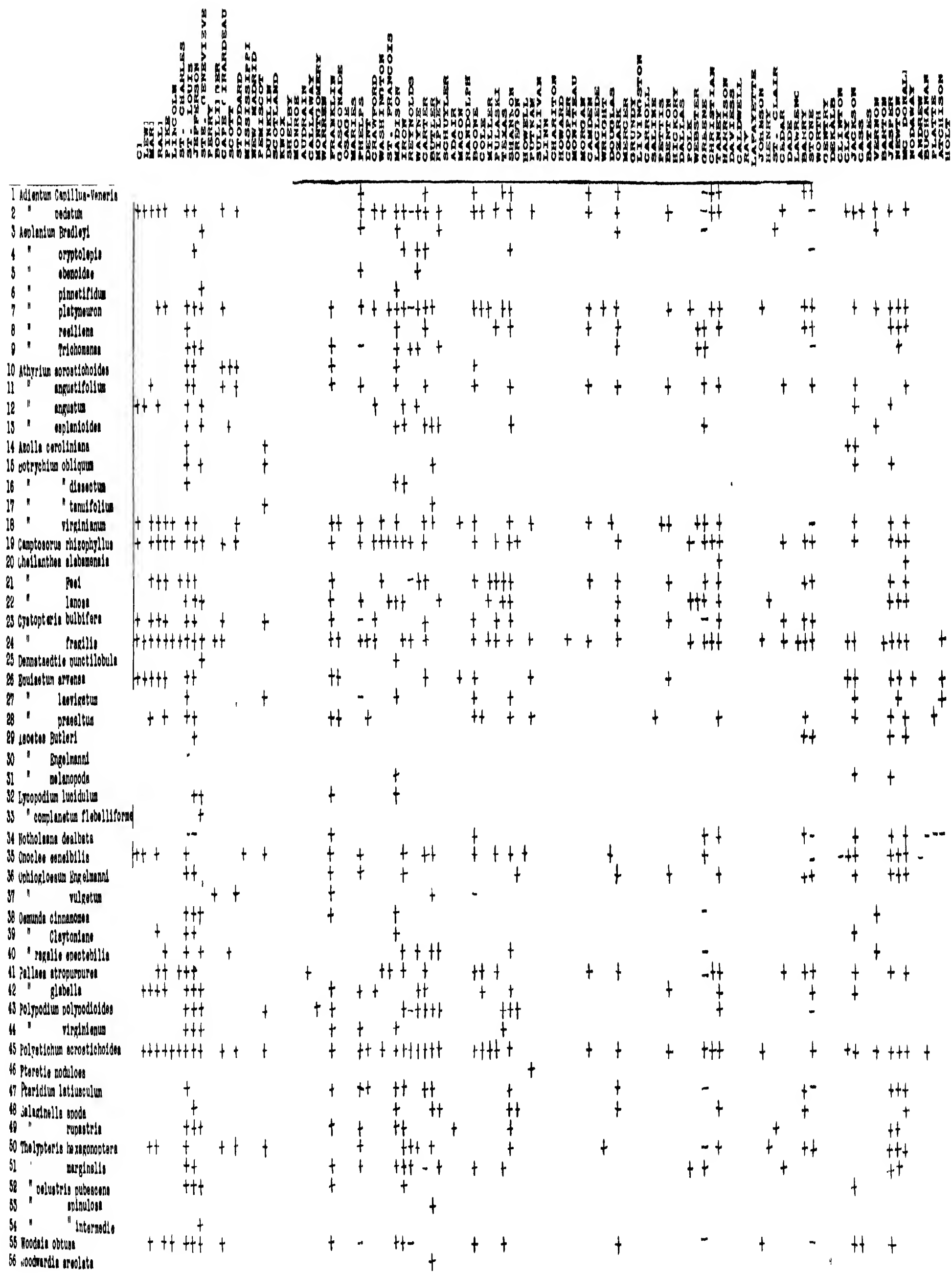


Fig. 2. Chart showing distribution of species by counties: – signifies reported only; +, specimens seen.

Rootstock short, oblique or erect; common stalk half or more above ground, constituting 1/3 to 2/5 the length of the plant; sterile segments sessile, ovate, 1–5 inches long, 0.5–2 inches broad; basal veins about 9; sporophyll 0.75–2 inches long, apiculate. May to August.

Distribution: Nova Scotia to Delaware, westward to Missouri and Texas. Southeastern Missouri—swamps or moist meadows.

Specimens examined: *Palmer 14716, 14732, 14748, 14765.*

2. **Ophioglossum Engelmanni** Prantl in Ber. Deut. Bot. Ges. 1: 351. 1883. Gray, p. 47; Britton & Brown, ed. 1 and 2, 1: 2.

Rootstock cylindrical; common stalk mostly below ground, sheathed by persistent leaf-bases; sterile segments sessile, elliptic to ovate, 1–3.5 inches long, 0.5–2 inches broad; basal veins 13 or more, transverse ones oblique; sporophyll 0.5–1 inch long, apiculate. March to October.

Distribution: South Carolina to Florida, westward to Arizona. Limestone glades, especially where there is a thin layer of fine rich and damp soil.

Specimens examined: *Palmer, Kellogg, Letterman, Engelmann, Bush, Pinkerton, Eggert, Greenman.*

BOTRYCHIUM

1. Bud wholly enclosed; cells of epidermis straight; sterile blade petiolate and never over 7 inches broad; common stalk mostly underground............2
1. Bud exposed along one side at base of rootstock; cells of epidermis flexuous; sterile blade sessile, 2–16 inches broad and nearly as long; common stalk above ground, half the length of plant...............................4
2. Ultimate segments deeply laciniate.................*2. B. obliquum* var. *dissectum*
2. Ultimate segments serrulate-dentate...3
3. Plant coarse; common stalk very short, underground; frond membranaceous on drying..*1. B. obliquum*
3. Plant slender; common stalk up to 2 inches above ground; frond coriaceous on drying...............................*3. B. obliquum* var. *tenuifolium*
4. Ultimate segments spatulate-shaped; ripe sporangia straw-colored, opening but slightly in dehiscence..............*5. B. virginianum* var. *intermedium*
4. Ultimate segments acute; ripe sporangia brown, opening widely in dehiscence. ....*4. B. virginianum*

1. **Botrychium obliquum** Mühl. in Willd. Sp. Pl. 5: 63. 1810. Gray, p. 48; Britton & Brown, ed. 1, 1: 3, ed. 2, 1: 5; Eaton, *pl. 20, fig. 2.*

B. ternatum Sw. in Schrad. Jour. für die Bot. 2 (1800): 111. 1801.

B. ternatum var. *obliquum* D. C. Eaton, Ferns N. Am. 1: 149. 1879.

Plant 5–15 inches tall; bud pilose; sterile blade long-stalked, 2–5 inches broad, tripinnatifid or tripinnate below; ultimate segments obliquely ovate or oblong-lanceolate, acutish terminal ones elongate; sporophyll long-stalked, usually stout, several-pinnate. August to October.

Distribution: Maine to Alabama, westward to Michigan and Texas. Moist woods, neutral soil.

Specimens examined: *Palmer, Bush, Kellogg, Letterman, Eggert, Trelease.*

2. **Botrychium obliquum** var. **dissectum** Prantl in K. Bot. Gard. Berlin, Jahrb. **3**: 342. 1884. Gray, p. 49; Britton & Brown, ed. 1, **1**: 3, ed. 2, **1**: 5; Eaton, *pl. 20, fig. 1.*

B. dissectum Spreng. Anleit. **3**: 172. 1804.

B. ternatum var. *dissectum* D. C. Eaton, Ferns N. Am. **1**: 150. 1879.

Character of rootstock, fruiting stalks, and texture of the plant all similar to the species; frond subternately divided, basal divisions unequally and broadly deltoid, decompound; the upper and secondary pinnae deltoid-lanceolate, pinnate, with laciniate or deeply cut pinnules; the ultimate divisions divergent, narrow, and incised.

Distribution: Maine to Florida, westward to Illinois and Missouri. Rich moist woods, deeply shaded.

Specimens examined: *Eggert, Letterman, Pinkerton.*

3. **Botrychium obliquum** var. **tenuifolium** (Underw.) Gilbert in Fern Bull. **11**: 99. 1903. Gray, p. 49. Pl. 5, fig. 2.

Plant small, up to 12 inches high; common stalk up to 2 inches high, not all underground, slender; blade ternate with few divisions, 5–10 cm. broad and about 5 cm. long; leaves coriaceous; ultimate segments broad, about 1.5 cm. long, ovate, acutish, conspicuously serrulate. September and October.

Distribution: Virginia to Arkansas. Southern Missouri—swampy land.

Specimens examined: Dunklin Co., *Bush 134*, and coll. of Sept. 28 and Oct. 28, 1897, *Trelease;* Butler Co., *Bush 3110.*

4. **Botrychium virginianum** (L.) Sw. in Schrad. Jour. für die Bot. **2** (1800): 111. 1801. Gray, p. 49; Britton & Brown, ed. 1, **1**: 4, ed. 2, **1**: 6; Eaton, *pl. 33.*

Common stalk slender, above ground 1/2–2/3 the length of

plant; blade sessile or nearly so, membranaceous, ultimate segments toothed; sporophyll long-stalked, bi–tripinnate. June and July.

Distribution: New Brunswick to Alabama, westward to Idaho and Texas. Rich moist woods.

Specimens examined: *Davis, Engelmann, Letterman, Palmer, Bush, Pinkerton, Eggert, Kellogg, Trelease, Larsen, Daniels, Emig, Blankenship.*

5. **Botrychium virginianum** var. **intermedium** Butters in Rhodora **19:** 207. 1917.

Ultimate segments of the sterile frond spatulate, penultimate ones ovate, not crowded; segments of the fertile frond opening wide in dehiscence; sporangia straw-colored, up to 0.8 mm. long.

Specimens examined: Monteer, Shannon Co., *Bush 4724;* Whiteside, Lincoln Co., *Davis*, coll. of 1910. The writer feels that the species is so generally variable that this variety is not very distinct.

POLYPODIACEAE

1. Indusia lacking........2
1. Indusia present, at least in early stages........4
2. Fruit dots near margin, becoming confluent, somewhat protected by overlapping leaf margins; lower surfaces of leaves covered with a white powder........*Notholaena*
2. Fruit dots separate, round, absolutely unprotected........3
3. Fronds linear, once-pinnatifid........*Polypodium*
3. Fronds triangular, more than once-pinnatifid........*Thelypteris*
4. Fronds dimorphic (fertile fronds not leaf-like)........5
4. Fronds monomorphic........6
5. Sterile fronds pinnatifid; veins anastomosed; fertile segments bipinnate.*Onoclea*
5. Sterile fronds bipinnatifid; veins free and unbranched; fertile segments pinnate........*Pteretis*
6. Indusia marginal........7
6. Indusia not marginal........11
7. Indusia not formed of revolute margins, but cup-shaped and opening terminally........*Dennstaedtia*
7. Indusia formed in part at least by revolute margins........8
8. Indusia definitely interrupted, occurring in separate little rounded flaps........*Adiantum*
8. Indusia continuous or only slightly broken........9
9. Indusia double........*Pteridium*
9. Indusia single........10
10. Blades with a few large, relatively smooth segments........*Pellaea*
10. Blades with many small, usually tomentose or hairy segments........*Cheilanthes*
11. Sori elongated........12
11. Sori rounded........15
12. Sori dispersed in two rows parallel to the midrib........*Woodwardia*

12. Sori dispersed irregularly on lateral veins 13
13. Veins anastomosed . . . . *Camptosorus*
13. Veins free 14
14. Sori straight . . . . *Asplenium*
14. Sori mostly curved over the end of veins . . . . *Athyrium*
15. Indusia peltate 16
15. Indusia attached at base or at one side 17
16. Indusia orbicular, attached centrally . . . . *Polystichum*
16. Indusia reniform, attached at sinus . . . . *Thelypteris*
17. Plants never glandular, but scaly on stipes and rootstocks; segments more or less acute; indusia tapering, attached at one side and becoming obscure at maturity . . . . *Cystopteris*
17. Plants glandular, also scaly; segments obtuse; indusia entire when young, splitting at top into several stellate segments . . . . *Woodsia*

ADIANTUM

1. Main rachis unbranched . . . . *1. A. Capillus-Veneris*
1. Main rachis dichotomously branched with 4–5 pinnae on each side . . *2. A. pedatum*

1. Adiantum Capillus-Veneris L. Sp. Pl. **2**: 1096. 1753. Gray, p. 36; Britton & Brown, ed. 1, **1**: 27, ed. 2, **2**: 31; Eaton, *pl. 37*. Venus hair.

Rootstock creeping, chaffy; stipe very slender, 3–12 inches long, black or brownish, slightly scaly; frond ovate-lanceolate, 6–12 inches long, 4–12 inches wide at base; pinnules wedge-obovate or rhomboid, long-stalked, glabrous, membranaceous, margins variously incised, veinlets flabellately forking from base; fruit dots lunate or transversely oblong. June to August.

Distribution: New Jersey to Florida, westward to South Dakota and California. Moist rocky places, ravines, wet limestone cliffs.

Specimens examined: *Kellogg, Daniels, Bush, Palmer, Trelease, Emig, Shepard.*

2. Adiantum pedatum L. Sp. Pl. **2**: 1095. 1753. Gray, p. 35; Britton & Brown, ed. 1, **1**: 27, ed. 2, **2**: 31; Eaton, *pl. 18*. Maidenhair.

Rootstock long, creeping, chaffy; stipe 9–18 inches long, shining, dark brown to black, slightly scaly at base, once-forked at summit, each division bearing on one side only several pinnate divisions (occasionally tri-forked); blade reniform-orbicular, 8–18 inches broad, membranaceous, glabrous; pinnules short-stalked, oblong, triangular or end ones fan-shaped; lower margin entire, all veins proceeding from it, upper margin lobed. June to August.

Distribution: Nova Scotia and Quebec to Georgia, westward to Alaska and California. Moist rich woods.

Specimens examined: *Bush, Davis, Engelmann, Palmer, Trelease, Pinkerton, Woodson, Kellogg, Broadhead, Emig, Mackenzie.*

ASPLENIUM

1. Blades pinnatifid, or only lower segments pinnate; apices long-attenuate........2
1. Blades 1–3-pinnate; apices not long-attenuate........3
2. Blades membranaceous; lower midribs black and shining on under side; apices crenate, sometimes proliferous........*3. A. ebenoides*
2. Blades subcoriaceous; midribs green, herbaceous; prolongations sinuous-margined, not proliferous........*4. A. pinnatifidum*
3. Blades 1-pinnate only; pinnae of regular shape; margins not deeply dissected. 4
3. Blades 2–3-pinnate or -pinnatifid; pinnae of irregular shape; margins deeply cut........6
4. Pinnae mostly roundish, not auriculate........*7. A. Trichomanes*
4. Pinnae oblong or lanceolate, auriculate........5
5. Stipes and rachises shiny black, slender; pinnae mostly opposite; sori few and nearer margins than costae........*6. A. resiliens*
5. Stipes and rachises shiny reddish brown, coarse; pinnae mostly alternate; sori numerous, near costae........*5. A. platyneuron*
6. Stipes and rachises green throughout; ultimate segments few, cuneate; margins fimbriate........*2. A. cryptolepis*
6. Stipes and rachises shining chestnut-brown; lower pinnae divided into obtuse segments; margins crenate........*1. A. Bradleyi*

1. Asplenium Bradleyi D. C. Eaton, Bull. Torr. Bot. Club **4:** 11. 1873. Gray, p. 39; Britton & Brown, ed. 1, **1:** 26, ed. 2, **1:** 30; Eaton, *pl. 51, figs, 4-8.*

Rootstock short, covered with narrow acuminate blackish-fuscous scales; fronds 4–7 inches high, oblong-lanceolate; stipes 2–3.5 inches long, dark chestnut and shining, tufted, slender; rachises brown, or green above; pinnae numerous, lower ones no larger than the middle ones, obtuse or acutish, toothed, in the largest fronds pinnatifid into oblong lobes which are toothed at apices; sori short, borne near midveins, becoming confluent; indusia membranaceous, persistent. July to September.

Distribution: New York to Georgia, westward to Missouri and Arkansas. On sandstone or chert outcrops—comparatively rare and local.

Specimens examined: *Palmer, Bush, Trelease, Mackenzie, Greene, Pinkerton, Van Dugen, Shepard.*

2. Asplenium cryptolepis (L.) Fernald in Rhodora **30:** 37.

1928. Gray, p. 39; Britton & Brown, ed. 1, **1**: 25, ed. 2, **1**: 29; Eaton, *pl. 15, fig. 1.*

Asplenium Ruta-muraria L. Sp. Pl. **2**: 1081. 1753.

Rootstock short, creeping, entangled, tufted; fronds 1–6 inches tall; stipes and rachises entirely green or slightly brown at base; blades deltoid-ovate, smooth, subcoriaceous, bi–tri-pinnate; ultimate segments few, stalked, 3–14 mm. long, narrowly cuneate to roundish obovate; margins deeply fimbriate; veins flabellate, no midveins; sori few (2–4 per pinna), oblong, covering whole segment when mature; indusia delicate with ciliated margin. July to September.

Distribution: Vermont to Georgia, westward to Illinois and Missouri. Shaded limestone cliffs—scarce.

Specimens examined: *Trelease, Palmer, Bush, Russell.*

3. **Asplenium ebenoides** R. R. Scott, Berkeley in Roy. Hort. Soc. Jour. N. S. **1**: 137. 1866. Gray, p. 38; Britton & Brown, ed. 1, **1**: 23, ed. 2, **1**: 26; Eaton, *pl. 4, fig. 2.*

Rootstock short, creeping, chaffy; fronds up to a foot high; stipes tufted, 4–9 inches long, young ones reddish brown, older ones black, shining, slender; lower rachises dark and shining underneath; blades firm-membranaceous, triangular-lanceolate, variable, 3–12 inches long, 1–3 inches at base, tapering to a long-acuminate apex which may become proliferous, lowest divisions distinct, shorter; sori numerous throughout, mostly single and opening obliquely upwards. August and September.

Distribution: Vermont to Alabama, westward to Missouri. Limestone—rare.

Specimens examined: *Trelease, Russell.*

4. **Asplenium pinnatifidum** Nutt. Gen. **2**: 251. 1818. Gray, p. 38; Britton & Brown, ed. 1, **1**: 22, ed. 2, **1**: 27; Eaton, *pl. 8, fig. 2.*

Rootstock short, creeping, branched, chaffy; fronds 6–9 inches high; stipes brownish near base and green above, clustered; blades 2–5 inches long, subcoriaceous, herbaceous, lanceolate-acuminate from broad and sub-hastate base, pinnatifid; the basal pinnae sometimes long-attenuate, lower lobes of pinnae roundish-ovate, margin crenate, upper pinnae gradually smaller and more adnate to winged rachises; sori straight, many, be-

coming confluent with age, mostly solitary, occurring also on the slender prolongation. July to October.

Distribution: Massachusetts to Alabama, westward to Missouri; recorded from Georgia and Arkansas. On La Motte sandstone only, in shaded crevices of cliffs.

Specimens examined: *Trelease, Engelmann, Russell, Pinkerton.*

5. **Asplenium platyneuron**[2] (L.) Oakes in D. C. Eaton, Ferns N. Am. **1**: 24. 1879. Gray, p. 39; Britton & Brown, ed. 1, **1**: 23, ed. 2, **1**: 27; Eaton, *pl. 4, fig. 1.* Ebony spleenwort.

Asplenium ebeneum Ait. Hort. Kew. **3**: 462. 1789.

Fronds 4–20 inches high, fertile ones tall and upright, sterile ones short and spreading; stipes and rachises reddish brown, shining, rather thick; blades linear-oblanceolate, tapering at base, once-pinnate; pinnae 20–40 pairs, lanceolate, 0.5–1.5 inches long, alternate, sessile, auricled on upper or both sides of base, and more or less overlapping rachis; sori 8–15 in number, nearer midveins than margins, becoming confluent. July to September.

Distribution: Vermont to Alabama, westward to Texas and Oklahoma; recorded from Ontario and Colorado. Rocky open woods, preferring alkaline soil.

Specimens examined: *Davis, Kellogg, Engelmann, Eggert, Trelease, Bush, Palmer, Daniels, Pinkerton, Woodson, Russell, Mann, Dewart, Emig, Krause, Meek.*

6. **Asplenium resiliens** Kunze, Linnaea **18**: 331. 1844. Gray, p. 39; Britton & Brown, ed. 1, **1**: 23, ed. 2, **1**: 27; Eaton, *pl. 36, figs. 5 & 6.*

Asplenium parvulum Mart. & Gal. in Mém. Acad. Brux. **15**: 60. 1842.

Rootstocks with black scales; fronds 4–12.5 inches long; stipes and rachises black and shining, slender; blades normally linear-oblanceolate, pinnate; pinnae 4–12 mm. long, mostly opposite, nearly sessile, upper edges auricled and on lower pinnae both edges auricled, deflexed; blades widest in middle; margins mostly entire or slightly crenate, tendency to incurve slightly; fruit dots nearer outer margins than midribs, nearly parallel to the midribs, oblong, few, sometimes becoming confluent. June to October.

[2] Var. *incisum* (E. C. Howe) Robinson in Rhodora **10**: 29. 1908, has very brittle stipes and the pinnae deeply pinnatifid. This appears to be merely an ecological variation.

Distribution: Massachusetts to Florida, westward to New Mexico. Limestone cliffs.

Specimens examined: *Trelease, Bush, Palmer, Russell, Pinkerton, Drouet.*

7. **Asplenium Trichomanes** L. Sp. Pl. **2:** 1080. 1753. Gray, p. 39; Britton & Brown, ed. 1, **1:** 24, ed. 2, **1:** 28; Eaton, *pl. 36, fig. 1.* Maidenhair spleenwort.

Rootstocks nearly erect, inconspicuously chaffy with narrow black scales; fronds 3–6 inches high; stipes slender, densely tufted, brownish-purple, polished, rachis similar to tip; blades once-pinnate, linear; pinnae 3–7 mm. long, herbaceous, mostly opposite, roundish, crenate margins, obliquely wedge-truncate at base, attached by narrow points; sori medial or nearer the midveins than margins, 3–6 pairs on outer sides of veins, becoming confluent; indusia membranaceous. July to September.

Distribution: Ontario to Alabama, westward to British Columbia and California; widely distributed but local. Sandstone rocks where plenty of water is available.

Specimens examined: *Kellogg, Letterman, Eggert, Engelmann, Palmer, Russell, Pinkerton, Trelease, Morrison, Rickett, Mackenzie, Blankenship.*

ATHYRIUM

1. Fronds simply pinnate .... *1. A. angustifolium*
1. Fronds more than pinnate 2
2. Fronds deeply bipinnatifid, margins lightly serrate-crenate .... *2. A. acrostichoides*
2. Fronds usually tripinnatifid, margins deeply and irregularly incised 3
3. Rhizomes creeping, not densely covered with persistent leaf-bases; fronds widest near base; indusia with glandular cilia; spores nigrescent, wrinkled. .... *3. A. asplenioides*
3. Rhizomes horizontal, completely concealed by thick fleshy bases of old fronds; fronds widest near middle; indusia toothed or short-ciliate, never glandular; spores yellow, slightly papillate .... *4. A. angustum*

1. **Athyrium angustifolium** (Michx.) Milde in Bot. Zeit. **48:** 376. 1886. Gray, p. 39; Britton & Brown, ed. 1, **1:** 24, ed. 2, **1:** 28; Eaton, *pl. 56, fig. 1.* Narrow-leaved spleenwort.

Asplenium pycnocarpon Spreng. Anleit. **3:** 112. 1804.

Asplenium angustifolium Michx. Fl. Bor. Am. **2:** 265. 1803.

Athyrium pycnocarpon Tidestrom, Elys. Marianum, p. 36. 1906.

Rootstocks stout, creeping, with many long, branched rootlets; stipes green except for brown base; fronds 1–2.5 feet long, membranaceous, herbaceous, pinnate; pinnae 2–5 inches long, 20–30 pairs, short-stalked, linear-oblong, attenuate, margins slightly

wavy; fertile pinnae near top, narrower and shorter; sori 20–30 pairs, linear, slightly curved, lying along outer of bifurcated veins; indusia firm, convex, concealed by strongly confluent sori at maturity. August and September.

Distribution: Quebec to Georgia, westward to Michigan and Missouri; recorded from Kansas and Minnesota. Moist woods and shaded ravines, reported occasionally on sandy soil.

Specimens examined: *Davis, Kellogg, Palmer, Eggert, Trelease, Bush, Pinkerton, Daniels, Emig, Glatfelter.*

2. **Athyrium acrostichoides** (Sw.) Diels in Engl. & Prantl, Nat. Pfl. 1⁴: 223. 1899. Gray, p. 39; Britton & Brown, ed. 1, **1**: 26, ed. 2, **1**: 30; Eaton, *pl. 50.* Silvery spleenwort.

Asplenium acrostichoides Sw. in Schrad. Jour. für die Bot. **2**: (1800): 54. 1801.

Asplenium thelypteroides Michx. Fl. Bor. Am. **2**: 265. 1803.

Athyrium thelypteroides (Michx.) Desv. in Mem. Soc. Linn. Paris [Prodr. p. 266] **6**: 266. 1827.

Rootstocks creeping, horizontal; stipes 8–16 inches long, straw-colored, herbaceous, with a few scales on lower portion; blades lanceolate to ovate-oblong, 1–3 feet long and 6–12 inches broad, narrowed to base, deeply bipinnatifid; ultimate segments distinct, obtuse; margins slightly serrate-crenate; sori 3–6 pairs per segment, arranged more or less evenly along lateral veins, mostly straight, oblong, some double. August to October.

Distribution: New Brunswick to Georgia, westward to Missouri; recorded northward to Minnesota. Rich moist woods, or moist sandy soil.

Specimens examined: *Palmer, Eggert, Davis, Letterman, Broadhead.*

3. **Athyrium asplenioides**[3] (Michx.) Desv. in Mem. Soc. Linn. Paris [Prodr. p. 266] **6**: 266. 1827. Gray, p. 40; Britton & Brown, ed. 1, **1**: 26, ed. 2, **1**: 30; Butters in Rhodora **19**: 169. 1917.

Asplenium Athyrium Spreng. Anleit. **3**: 113. 1804.

Athyrium Filix-foemina (L.) Roth in Römer's Arch. f. Bot. **2**¹: 106. 1799.

Rhizomes horizontally creeping, partially covered by short persistent leaf bases, the whole structure 1–1.5 cm. in diameter,

[3] This species and *A. angustum* are very difficult to distinguish. It is often necessary to have the whole plant, fruiting and not too mature, to be absolutely certain. I have taken the character of the spore as my ultimate criterion.

with conspicuous projections of new growths before fronds of the current season; stipes long, about equal to the deltoid lanceolate fronds; young growths covered with scales soon deciduous, these small and light tan-colored, cell walls thin and inconspicuous; fronds bipinnate to tripinnatifid, second pair of pinnae commonly the longest, the lowest only slightly shorter; pinnae narrower at base; pinnules variously incised but apex more or less obtuse due to the venation, since two veins usually end on the same level; sori longer and narrower than in *A. angustum*, on the anterior side of anterior vein of each lobe of pinnule, and sometimes on the lower veins, of typical athyroid type, rarely double; young indusia ciliate with multicellular glandular-tipped hairs nearly disappearing at maturity, leaving quite even margins; sporangia stalk frequently supplied with a glandular hair; spores furnished with a somewhat nigrescent, wrinkled exospore. July to October.

Distribution: Massachusetts to Florida, westward to Missouri and Texas. Shaded rich woods or cliffs, sandy soil.

Specimens examined: *Kellogg, Trelease, Palmer, Bush, Soulard, Blankenship.*

4. **Athyrium angustum**[4] (Willd.) Presl in Rel. Haenk. **1**: 39. 1825. Gray, p. 40; Britton & Brown, ed. 1, **1**: 26, ed. 2, **1**: 30; Butters in Rhodora **19**: 169. 1917.

Asplenium Michauxii Spreng. Syst. **4**: 88. 1827.

Asplenium Filix-foemina (L.) Roth in Römer's Arch. f. Bot. **2**[1]: 106. 1799.

Rhizomes horizontal and somewhat oblique, condensed and completely covered by thick fleshy bases, 2–5 cm. in diameter; stipes up to half as long as the frond, a moderate number of scales persistent, 1 × 1.5 mm., dark opaque with thick darker cell walls and narrow cells; fronds bi–tripinnatifid, middle of fronds widest and lower pinnae much shorter and often deflexed, often large forms and polymorphic; pinnae not narrower at base; pinnules and segments with acute apices, due to one vein ending considerably beyond any of its neighbors; fertile fronds consider-

[4] Butters describes two varieties, namely: var. *elatius* and var. *rubellum*, distinguished chiefly by the dimorphism and thicker texture of the former (a sun form) and the monomorphism and thinner texture of the latter (a shade form). He claims that the latter has a more northerly distribution; but in Missouri the two seem to be purely ecological variations and scarcely worth varietal rank.

ably narrower and more acute than sterile ones; sori short and wide, of typical athyroid type; indusia never glandular but persistently short-ciliate; sporangia stalk rarely bearing glandular hair; spores bright yellow and slightly papillate, no exospore and not wrinkled. June to October.

Distribution: Labrador to Pennsylvania, westward to South Dakota and Missouri. Rich woods.

Specimens examined: *Bush, Davis, Palmer, Engelmann, Kellogg, Eggert, Russell.*

CAMPTOSORUS

1. **Camptosorus rhizophyllus** (L.) Link, Hort. Berol. **2**: 69. 1833. Gray, p. 40; Britton & Brown, ed. 1, **1**: 21, ed. 2, **1**: 26; Eaton, *pl. 8, fig. 1.* Walking fern.

Rootstocks short, creeping; stipes grouped in tufts, spreading, green, fleshy, 1–6 inches long; blades evergreen, subcoriaceous, 4–12 inches long, base auriculate, cordate or hastate, apex attenuate and filiform, rooting at tips (or from auricles); sori numerous, straight or slightly curved, single and on inside of and parallel to veins, near midribs, on both sides of outer veins and becoming confluent at exterior tips; indusia membranaceous. All year.

Distribution: Ontario to Alabama, westward to Minnesota and Oklahoma. Limestone rocks, usually associated with *Entodon* (a moss).

Specimens examined: *Bush, Davis, Engelmann, Trelease, Kellogg, Daniels, Palmer, Pinkerton, Dewart, Russell, Rickett, Weller.*

CHEILANTHES

1. Fronds relatively smooth.................................*1. C. alabamensis*
1. Fronds hairy or tomentose.................................2
2. Plants small, 2–6 inches tall, matted; mature stipes nearly glabrous..*2. C. Feei*
2. Plants taller, 4–20 inches, not matted; stipes hirsute..............*3. C. lanosa*

1. **Cheilanthes alabamensis** (Buckl.) Kunze in Linnaea **20**: 4. 1847. Gray, p. 36; Britton & Brown, ed. 1, **1**: 30, ed. 2, **1**: 34; Eaton, *pl. 57, fig. 7.*

Rootstocks creeping, short, slender, with dark ferruginous scales; stipes black, wiry, slightly villous at base due to fine rusty scales 3–7 mm. long; blades scabrous to smooth, 2–10 inches long, lanceolate, bipinnate; pinnae acuminate, lower ones shorter than those above; pinnules often auriculate; indusia broad, pale but firm, frequently broken by incision of pinnules. August to October.

Distribution: Florida, westward to Missouri and Arizona. Limestone cliffs.
Specimens examined: *Kellogg, Palmer, Bush.*

2. **Cheilanthes Feei** Moore, Ind. Fil. Gen. 38. 1857. Gray, p. 36; Britton & Brown, ed. 2, **1**: 34; Eaton, *pl. 6, fig. 1.*

Cheilanthes lanuginosa Nutt. in Hk. Sp. Fil. **2**: 99. 1852.

Rootstocks short, clothed with narrow scales of black centers and thin brown edges; fronds 2–6 inches tall; stipes densely tufted, black or brown, originally woolly, becoming glabrous when mature; blades bi–tripinnate, slightly tomentose above and woolly below; pinnules divided into minute rounded segments, densely crowded; indusia herbaceous, continuous. July to October.

Distribution: Wisconsin to Texas, westward to Nevada and Arizona. Limestone cliffs in dry and exposed localities.

Specimens examined: *Davis, Kellogg, Engelmann, Trelease, Bush, Palmer, Daniels, Pinkerton, Morrison, Uphof.*

3. **Cheilanthes lanosa** (Michx.) Watt in Jour. Bot. **12**: 48. 1874. Gray, p. 36; Britton & Brown, ed. 1, **1**: 31, ed. 2, **1**: 34; Eaton, *pl. 2, fig. 2.*

Cheilanthes vestita Sw. Syn. Fil. 128. 1806.

Rootstocks short, creeping, with pale brown scales; fronds 4–16 inches long; stipes wiry, dark brown, hirsute; blades herbaceous, bipinnate; pinnae hirsute and somewhat glandular; indusia inconspicuous, discontinuous. July to September.

Distribution: New York to Alabama, westward to Oklahoma; recorded from Connecticut and Texas. Sandstone rocks, usually in dry and exposed places.

Specimens examined: *Kellogg, Eggert, Letterman, Palmer, Broadhead, Pinkerton, Muller, Glatfelter, Mackenzie, Swallow, Emig, Blankenship, Link.*

CYSTOPTERIS

1. Pinnae short-stalked on rachises; pinnules at least narrowed at points of attachment; segments ovate, acute, usually variously incised; indusia truncate.. *1. C. fragilis*
1. Pinnae sessile on rachises; pinnules oblong, obtuse, regularly toothed; indusia round or pointed at apex...2
2. Fronds long-attenuate.................................... *2. C. bulbifera*
2. Fronds not long-attenuate..................... *3. C. bulbifera* var. *horizontalis*

1. **Cystopteris fragilis**[5] (L.) Bernh. in Schrad. Neues Jour.

[5] An exceedingly variable species. Hybridization with *C. bulbifera* might account for some of the aberration. Forms bearing bulblets have been included under this group, as that character does not seem to be a constant feature for *C. bulbifera* alone.

Bot. 1^2: 27. 1806. Gray, p. 43; Britton & Brown, ed. 1, 1: 13, ed. 2, 1: 15; Eaton, *pl. 53, fig. 1.*

Filix fragilis Underw. Nat. Ferns, ed. 6, 119. 1900.

Rootstocks elongated, often 4–5 inches long, or shorter and condensed, slender, but covered with persistent leaf-bases, chaffy at apex, scales delicate, ovate, acuminate, ferruginous; stipes in a dense cluster, slender, brittle, 4–6 inches long; blades 6–8 inches long and about half as wide, thin and membranaceous, ovate-lanceolate; basal pinnae commonly narrower than the second and third pairs, apparently bipinnate but segments usually connected by narrowly winged midribs, segments roundish-oval to ovate to rhomboid-ovate to ovate-lanceolate, toothed, dentate or irregularly laciniate; veinlets pinnately arranged on midveins, lower ones forked; sori small, roundish, seated on middle of veins nearest midrib; indusia delicate, rounded, ovate, or occasionally with narrow beak-like points, concealed by mature sporangia; lower pinnae often sterile. May to July.

Distribution: Cosmopolitan. Rocky soil, moist woods, preferring alkaline soil.

Specimens examined: *Davis, Engelmann, Trelease, Bush, Palmer, Pinkerton, Eggert, Kellogg, Woodson, Harrison, Mann, Daniels, Blankenship, Duncan, Williams.*

2. **Cystopteris bulbifera** (L.) Bernh. in Schrad. Neues Jour. Bot. 1^2: 10. 1806. Gray, p. 43; Britton & Brown, ed. 1, 1: 12, ed. 2, 1: 15; Eaton, *pl. 53, fig. 13.*

Filix bulbifera Underw. Nat. Ferns, ed. 6, 119. 1900.

Rootstocks seldom over one inch long, chaffy at apex and covered with persistent leaf-bases; stipes slender, rather brittle, 6–10 inches long; blades submembranaceous but of a brittle rigidity, triangular-attenuate, 1–4 feet long, 3–5 inches broad at base; pinnae attenuated upward, bipinnate at base, upper pinnules attached by winged rachises; pinnae numerous (up to 40 pairs), oblong; pinnules oblong, obtuse, pinnately lobed; sori numerous, all pinnae fertile, arranged in rows along each side of midveins of pinnules, placed on the lowest superior veinlet of each group near its middle and so near the midvein; indusia truncate and fragile, covered by mature sporangia; bulblets sometimes present on the under side of the frond attached near the base of or on the pinnae. July to August.

Distribution: Newfoundland to Georgia, westward to Michigan and Arkansas;

recorded from Utah and Arizona. Rocky soil, preferring limestone, in moist shady situations.

Specimens examined: *Bush, Davis, Kellogg, Trelease, Palmer, Pinkerton, Daniels, Letterman.*

3. **Cystopteris bulbifera var. horizontalis** Lawson in Bot. Soc. Edinb. Trans. **8**: 40. 1866. Pl. 5, fig. 1.

Fronds triangular-lanceolate, broad at base, not more than three or four times longer than broad; pinnae horizontal; lowest pinnules often quite broad with irregularly cut lobes and bearing numerous medium-sized sori along the lateral veins, sometimes almost tripinnate, or pinnules irregularly lobed, merely ovate-lanceolate. May to October.

Distribution: southern Missouri and northern Arkansas. Damp limestone bluffs.

Specimens examined: Ilasco, Ralls Co., *Davis 2663;* Sulphur Springs, Jefferson Co., coll. of Oct. 23, 1898, *Trelease;* Terre Bleue Cr., Ste. Genevieve Co., coll. of Aug. 29, 30, 1898, *Trelease;* Lesterville, Reynolds Co., coll. of June 5, 1929, *Kellogg;* Tecumseh, Ozark Co., *Palmer 32896.*

DENNSTAEDTIA

1. **Dennstaedtia punctilobula** (Michx.) Moore, Ind. Fil. Gen. 97. 1857. Gray, p. 45; Britton & Brown, ed. 1, **1**: 12, ed. 2, **1**: 14; Eaton, *pl. 44.*

Dicksonia pilosiuscula Willd. Enum. 1076. 1809.

Dicksonia punctilobula Hk. Sp. Fil. **1**: 79. 1846.

Rootstocks extensively creeping, slender, scaleless but finely hairy at tips, irregularly branching with many long slender rootlets; stipes rather stout, light brown, chaffless, slightly puberulent; blades 1–3 feet long, ovate-lanceolate, acuminate, delicately herbaceous, hairy and minutely glandular, tripinnatifid; pinnae numerous, lanceolate, pointed, second pair a little longer than first; pinnules adnate to rachis and usually decurrent on it, rhomboid-ovate, pinnatifid into oblong and obtuse cut-toothed lobes; sori minute, on upper margins of the lobes of the pinnules; indusia cup-like, delicate. August.

Distribution: New Brunswick to Georgia, westward to Illinois and Missouri. Crevices of La Motte sandstone, rare.

Specimens examined: *Trelease, Russell, Eggert, Pinkerton.*

NOTHOLAENA

1. **Notholaena dealbata** (Pursh) Kunze in Amer. Jour. Sci. II. **6**: 82. 1848, as *Nothochlaena.* Gray, p. 35; Britton & Brown, ed. 1, **1**: 32, ed. 2, **1**: 35; Eaton, *pl. 9, fig. 2.*

Cheilanthes dealbata Pursh, Fl. Am. Sept. **2**: 671. 1814.
Nothochlaena pulchella Kunze in Bot. Zeit. **1**: 633. 1843.
Pellaea dealbata (Pursh) Prantl in Engler's Bot. Jahrb. **3**: 417. 1882.
Notholaena nivea var. *dealbata* Davenp. in Cat. Davenp. Herb. Suppl. 44. 1883.

Rootstocks short, creeping, with narrow brown chaffy scales; stipes 1–4 inches long, tufted, wiry, slender, copper-brown, as are the rachises; blades 2–4 inches long, broadly deltoid-ovate, 4–5-pinnate, all but ultimate segments alternate, those sometimes opposite; segments obovate-oval and entire or several-lobed, 1–2 mm. broad, upper surfaces pale green, coriaceous, lower white and powdery, giving a silvery appearance; sporangia seated on upper portions of the veins; no indusia, but a protection afforded by the slightly turned-back margins. June to September.

Distribution: Missouri and Kansas to central Texas; recorded from Nebraska. Dry calcareous rocks.

Specimens examined: *Daniels, Bush, Palmer, Blankenship.*

ONOCLEA

1. **Onoclea sensibilis** L. Sp. Pl. **2**: 1062. 1753. Gray, p. 45; Britton & Brown, ed. 1, **1**: 9, ed. 2, **1**: 11; Eaton, *pl. 72, fig. 1.* Sensitive fern.

Rootstocks slender, creeping, rooting freely and often forking; stipes coarse, straw-like, hollow, flattened, light brown when dry; sterile blades triangular or triovate, midribs winged, widening toward the apex, sinuses rounded; lowest segments broadly lanceolate, herbaceous, sensitive to frost; veins conspicuous, reticulate; margins variously rounded, lobed, toothed, serrate or acute; fertile fronds 12–18 inches long, pinnate, contracted; each segment a pouch filled with several sporangia; delicate hood-like indusia. August to November.

Distribution: Newfoundland to Florida, westward to Kansas. Swamps or damp rich soil.

Specimens examined: *Bush, Davis, Eggert, Palmer, Morrison, Muller, Daniels, Blankenship, Mackenzie, Williams.*

PELLAEA

1. Pinnae dichotomously branched at apex........*3. P. atropurpurea* var. *cristata*
1. Pinnae not branched at apex..2

2. Stipes smooth, reddish-brown; pinnae usually membranaceous, pale green, short, more or less rounded at both corners and tending to divide at bases into two or more parts ... . *1. P. glabella*
2. Stipes scabrous, dark purplish-black; pinnae coriaceous, blue-green, elongate and seldom redivided . . . .*2. P. atropurpurea*

1. **Pellaea glabella** Mett., Kuhn in Linnaea **36:** 87. 1869. Gray, p. 37; Britton & Brown, ed. 2, **1:** 33.

Pellaea atropurpurea var. *Bushii* Mackenzie, Flora Jackson County, Mo., p. 5. 1902.

Stipes and rachises brownish-red, smooth or but slightly hairy; fronds simply pinnate above, the lower ternate or rarely quinate (the entire pinnule seems to be breaking at the base—a possible tendency toward compound pinnules); pinnae membranaceous to coriaceous but always pale green. April to October.

Distribution: Ontario and Vermont to Pennsylvania, westward to South Dakota and northern Arkansas. Exposed high places on limestone cliffs.

Specimens examined: *Davis, Eggert, Kellogg, Bush, Palmer, Pinkerton, Trelease.*

2. **Pellaea atropurpurea** (L.) Link, Fil. Sp. in Hort. Berol. 59. 1841. Gray, p. 37; Britton & Brown, ed. 1, **1:** 29, ed. 2, **1:** 33; Eaton, *pl. 54, fig. 4.*

Rootstock short, densely covered with rusty scales about 2 mm. in length; fronds 4–12 inches long, pinnate or below bipinnate, coriaceous; fertile segments linear, more or less pointed at apex; sterile segments approaching oval, shortly stalked; veins obscure; continuous indusia of reflexed margins. June to September.

Distribution. Connecticut to Florida, westward to South Dakota and Texas. Near small limestone rocks or on top of cliffs where there is loose soil.

Specimens examined: *Davis, Engelmann, Trelease, Broadhead, Bush, Palmer, Pinkerton, Kellogg, Daniels.*

3. **Pellaea atropurpurea** var. **cristata** Trel. in Rept. Mo. Bot. Gard. **12:** 77. 1901. Gray, p. 37.

Pinnae dichotomously forked.

Distribution: known only from Eureka, Missouri. Limestone.

Specimens examined: Eureka, 1899, *Pauls.*

POLYPODIUM

1. Blades smooth, green. ....*1. P. virginianum*
1. Blades densely scaly, grayish.................. ....*2. P. polypodioides*

1. **Polypodium virginianum** L. Sp. Pl. **2:** 1085. 1753. Gray, p. 34; Britton & Brown, ed. 1, **1:** 32, ed. 2, **1:** 36; Eaton, *pl. 31, fig. 1.* Common polypody.

Polypodium vulgare L. Sp. Pl. **2:** 1085. 1753.

Rootstocks close to surface of soil, covered with chaffy, red-brown scales; stipes smooth, herbaceous, light green; blades ovate-oblong or narrowly oblong, subcoriaceous or chartaceous, evergreen, simple, deeply pinnatifid, smooth; segments linear-oblong, obtuse or slightly acute, crenulate and serrate, sinuses rounded, alternate, margins obscurely dentate; sori large, naked. July.

Distribution: Newfoundland to Florida, westward to Minnesota and Arkansas. On sandstone or sandy soil.

Specimens examined: *Eggert, Russell, Engelmann, Trelease, Pinkerton, Letterman, Greene.*

2. **Polypodium polypodioides** (L.) Hitchc. in Rept. Mo. Bot. Gard. **4:** 156. 1893. Gray, p. 34; Britton & Brown, ed. 1, **1:** 33, ed. 2, **1:** 36; Eaton, *pl. 26, fig. 2.* Gray polypody.

Polypodium incanum Sw. Fl. Ind. Occ. **3:** 1645. 1806.

Rootstocks woody, covered with small dark brown scales; stipes 1–4 inches long, slender, bearing peltate ovate scales with dark brown centers; blades oblong-lanceolate, pinnate; segments oblong, obtuse, entire, sessile, separated by rounded sinuses, alternate, upper surfaces smooth or with few scales, lower densely scaly; fruit dots small and naked. July to September.

Distribution: Massachusetts to Florida, westward to Missouri and Texas. Usually an epiphyte on swamp trees, particularly *Taxodium distichum;* also on sandstone rocks.

Specimens examined: *Eggert, Trelease, Bush, Pinkerton, Rickett, Kellogg, Mackenzie, Meek.*

POLYSTICHUM

1. Margins serrulate; fertile pinnae contracted; sori confluent. . . . *1. P. acrostichoides*
1. Margins deeply toothed or pinnatifid; fertile pinnae scarcely contracted; sori not confluent and appearing only on tips of lower pinnae. . . . . *2. P. acrostichoides* var. *incisum*

1. **Polystichum acrostichoides** (Michx.) Schott, Gen. Fil. 17. 1834. Gray, p. 40; Britton & Brown, ed. 1, **1:** 14, ed. 2, **1:** 16; Eaton, *pl. 34.* Christmas fern.

Aspidium acrostichoides Sw. Syn. Fil. 44. 1806.

Dryopteris acrostichoides Kuntze, Rev. Gen. Pl. **2:** 812. 1891.

Rootstocks stout, creeping, with persistent leaf-bases; stipes densely tufted, with chaff of large golden-brown scales, 5–7 mm. wide; blades lanceolate, pinnate, 1–2 feet long, 3–5 inches wide, rigid, evergreen, subcoriaceous; pinnae numerous, 1–3 inches long, oblong-lanceolate, short-stalked, upwardly falcate or lowest slightly deflexed, apex acutish, upper sides auriculate; margins serrulate to incised with incurved bristle-pointed teeth; veins free, branching three to four times; upper pinnae of fertile fronds more or less contracted and heavily soriferous; sori terminal on lower veinlets in 2–4 rows, becoming confluent with age; indusia round, indurated, not glandular, persistent. July to August.

Distribution: Maine to Florida, westward to Michigan and Texas; recorded from Nova Scotia. Shady hillsides of ravines, in rich soil which is interspersed with rocks; common.

Specimens examined: *Bush, Davis, Eggert, Trelease, Palmer, Pinkerton, Emig, Kellogg, Daniels, Thomas, Mackenzie.*

2. **Polystichum acrostichoides** var. **incisum** Gray, Man. Bot. ed. 1, 632. 1848. Gray, p. 40; Britton & Brown, ed. 1, **1**: 14, ed. 2, **1**: 16.

Polystichum acrostichoides var. *Schweinitzii* (Beck) Small in Bull. Torr. Bot. Club **20**: 464. 1893.

Aspidium schweinitzii Beck, Bot. North. & Mid. States, ed. 1, 449. 1833.

Aspidium acrostichoides var. *incisum* D. C. Eaton, Ferns N. Am. **1**: 258. 1879.

Segments few and distant, large, irregularly incised; upper pinnae covered by confluent sori, lower ones fertile at tips only, sori large; veins numerous, frequently overlapping to form irregular areoles.

Distribution: This seems to be nearly as common as the type in southern Missouri and northern Arkansas; but since there appears to be a series of intermediate forms between the two I have not attempted to separate the individual ranges.

PTERETIS

1. **Pteretis nodulosa** (Michx.) Nieuwl. in Am. Midl. Nat. **4**: 334. 1916. Gray, p. 45; Britton & Brown, ed. 1, **1**: 9, ed. 2, **1**: 11; Eaton, *pl. 73.* Ostrich fern.

Osmunda Struthiopteris L. Sp. Pl. **2**: 1066. 1753.

Onoclea Struthiopteris Hoffm. Deutsch. Fl. **2**: 11. 1795.

Struthiopteris germanica Willd. Enum. 1071. 1809.

Matteuccia Struthiopteris (L.) Todaro in Syn. Pl. Acot. Vasc. Sicilia, p. 30. 1866.

Matteuccia nodulosa (Michx.) Fernald in Rhodora **17**: 164. 1915.

Rootstocks stout and ascending, with slender underground stolons; sterile blades 2–7 feet high, 6–15 inches broad, short-stalked, broadly oblanceolate, abruptly short-acuminate, gradually narrowed below middle, lower pinnae reduced; pinnae narrow, deeply pinnatifid; segments oblong, obtuse, entire; veins simple, fertile blades 1–7.5 feet high, with pod-like brown pinnae, included sori confluent. July.

Distribution: Newfoundland to New York, westward to Michigan and Missouri; recorded from Virginia. Alluvial soil.

Specimens examined: Livonia, Putnam Co., *Bush 7780, 7780A, 7780B.*

PTERIDIUM

1. Pinnules much elongated, seldom redivided...*2. P. latiusculum* var. *pseudocaudatum*
1. Pinnules oblong-lanceolate, at least a few pinnatifid...........*1. P. latiusculum*

1. Pteridium latiusculum (Desv.) Hieron. Wissenschaftl. Ergeb. d. Schwed. Rhodesia-Kongo-Exp. 1911–12, Heft 1, p. 7. 1914; Maxon in Am. Fern Jour. **9**: 43. 1919. Gray, p. 36; Britton & Brown, ed. 1, **1**: 28, ed. 2, **1**: 32; Eaton, *pl. 35.*

Pteris aquilina L. Sp. Pl. **2**: 1075. 1753.

Pteridium aquilinum Kuhn in Decken, Reisen in Ost-Afrika **3**^{3}: 11. 1879.

Rootstocks cord-like, creeping, blackish, deeply buried; stipes solitary, erect, naked, 1–3 feet high, swollen at base, brownish; blades 2–4 feet long, 1–3 feet broad, triangular-ovate, rigidly subcoriaceous, subternate; the long-stalked basal pinnae and middle ones bipinnate, those above lobed or simple; segments oblong-lanceolate, under surfaces glabrous or pubescent; veins close-packed, free; indusia continuous around the edge of the pinnules, double. July to September.

Distribution: Cosmopolitan, open woods, preferring sandy soil.

Specimens examined: *Kellogg, Eggert, Palmer, Bush.*

2. Pteridium latiusculum var. pseudocaudatum Maxon in Am. Fern Jour. **9**: 44. 1919. Gray, p. 36; Britton & Brown, ed. 2, **1**: 32.

The variety occurs in this region but does not seem to have a distribution different from that of the species. It is distinguished by its very narrow elongated pinnules.

THELYPTERIS

Dryopteris Adans.
Polystichum Roth
Aspidium Swartz
Nephrodium Richard
Lastrea Bory
Phegopteris (Presl) Fée

1. Indusia absent........ ....*5. T. hexagonoptera*
1. Indusia present 2
2. Blades bipinnatifid or bipinnate; segments not spinulose....................3
2. Blades tripinnatifid or tripinnate; segments spinulose......................4
3. Sori medial, small; blades membranaceous, not evergreen.................
....*1. T. palustris* var. *pubescens*
3. Sori near margins, large; blades subcoriaceous, evergreen......*2. T. marginalis*
4. Indusia glandless; pinnae decidedly oblique to rachises, scales of stipe pale brown ....*3. T. spinulosa*
4. Indusia glandular; pinnae more or less at right angles to rachises; scales of stipe brown with a dark center... ....*4. T. spinulosa* var. *intermedia*

1. **Thelypteris palustris** var. **pubescens**[6] (Lawson) Fernald in Rhodora **31**: 34. 1929. Gray, p. 41; Britton & Brown, ed. 1, **1**: 15, ed. 2, **1**: 18; Eaton, *pl. 30.* Marsh shield-fern.

Thelypteris Thelypteris Nieuwl. in Am. Midl. Nat. **1**: 226. 1910.

Rootstocks slender, creeping, blackish, nearly naked; stipes as long or longer than the blades, blackish at base, sparingly chaffy; blades oblong-lanceolate, pinnate, 1–3 feet long, 4–6 inches wide, membranaceous, scarcely narrowed at base, short-acuminate; pinnae 20–30 pairs, alternate, short-stalked, approximately at right angles to stalks, linear-lanceolate, broadest at base, deeply pinnatifid; segments oblong-obtuse, mostly entire; veins pinnate, usually once-forked; fertile fronds usually on longer stalks and of narrower segments than the former; sori nearly medial, crowded; indusia glabrous. August.

[6] Eaton mentions an unusual form—"the lower two or three pairs are usually but little shorter than those above them; but fronds are occasionally found in which they are conspicuously reduced." Such a form is one from Iron Lake, Iron Co., *Kellogg 1634.*

Distribution: New Brunswick to Florida, westward to Texas. Wet woods.
Specimens examined: *Eggert, Kellogg, Bush, Pinkerton.*

2. **Thelypteris marginalis** (L.) Nieuwl. in Am. Midl. Nat. **1**: 226. 1910. Gray, p. 42; Britton & Brown, ed. 1, **1**: 17, ed. 2, **1**: 20; Eaton, *pl. 55*. Evergreen wood fern.

Rootstocks stout, ascending, covered with long chaffy brown scales; stipes several inches to a foot long, light tan, somewhat chaffy; blades 6–30 inches long, evergreen, subcoriaceous, ovate-lanceolate, scarcely narrowed at base, deeply bipinnatifid; pinnae numerous, practically sessile, lanceolate, acuminate, slightly broader above the base; pinnules adnate to narrowly winged secondary rachis, oblong to oblong-lanceolate, faintly crenately-toothed; veins free, forked or pinnately branched; sori large, near margins of segments; indusia hard, orbicular-reniform, glabrous, dark brown. July to August.

Distribution: Nova Scotia to Georgia, westward to Kansas and Oklahoma. Sandstone ledges where it is moderately moist.

Specimens examined: *Letterman, Engelmann, Eggert, Kellogg, Palmer, Pinkerton, Muller, Rickett, Mackenzie, Broadhead, Link, Blankenship, Trelease.*

3. **Thelypteris spinulosa** (Retz.) Nieuwl. in Am. Midl. Nat. **1**: 226. 1910. Gray, p. 43; Britton & Brown, ed. 1, **1**: 18, ed. 2, **1**: 21; Eaton, *pl. 68*. Spinulose shield-fern.

Rootstocks stout, creeping, chaffy; stipes 4–14 inches long, chaffy; blades 0.5–3 feet long, ovate-lanceolate to oblong, acuminate, bi-tripinnate, firmly membranaceous; primary pinnae short-stalked, lower pairs triangular-ovate to triangular-lanceolate, remaining pinnae gradually narrower in outline; secondary rachises narrowly wing-margined; pinnules oblong, subacute, incised with spinulose-serrate lobes; sori small, sub-marginal, terminal on veinlets; indusia flat, round-reniform, glandless.

Distribution: Labrador to Virginia, westward to Idaho. Moist woods, alluvial soil.

Specimens examined: Neeleyville, Butler Co., coll. of Oct. 30, 1899, *Russell.*

4. **Thelypteris spinulosa** var. **intermedia** (Retz.) Nieuwl. in Am. Midl. Nat. **2**: 278. 1912. Gray, p. 43; Britton & Brown, ed. 2, **1**: 22.

Similar to the species except for the glandular indusia and right-angled relation of pinnae to rachis.

Distribution: In Missouri—more northern, sandy soil.

Specimens examined: Pickle Springs, Ste. Genevieve Co., *Pinkerton 1;* and coll. of May 21, 1930, *Kellogg.*

5. **Thelypteris hexagonoptera** (Michx.) Weatherby in Rhodora 21: 179. 1919. Gray, p. 35; Britton & Brown, ed. 1, **1**: 19, ed. 2, **1**: 23; Eaton, *pl. 65.* Broad beech-fern.

Phegopteris hexagonoptera (Michx.) Fée, Gen. Fil. 243. 1850–2.

Rootstocks elongated, slender, creeping, chaffy with gold scales; stipes 8–20 inches long, slender, greenish, or straw-colored; blades triangular, 7–12 inches long, 7–15 inches wide, thinly herbaceous, deep green, slightly hairy or granular, bipinnatifid; pinnae adnate to winged rachis, the lowermost ones broadest and largely ovate to ovate-lanceolate, and others lanceolate; segments usually bluntly acuminate and crenate; veins pinnate and free, branched or not; sori borne over whole frond, small, near end of veins and so near margins; no indusia. August.

Distribution: New Brunswick to Delaware, westward to Oklahoma. Moist woods and ravines.

Specimens examined: *Davis, Eggert, Palmer, Kellogg, Bush, Pinkerton, Rickett, Link.*

WOODSIA

1. **Woodsia obtusa** (Spreng.) Torr. Cat. Pl. in Geol. Rept. N. Y. 195. 1840. Gray, p. 44; Britton & Brown, ed. 1, **1**: 11, ed. 2, **1**: 14; Eaton, *pl. 71.*

Rootstocks short, creeping, chaffy with narrow light brown scales; stipes 2–6 inches long, green with darkish base in living plants and drying to a bright brownish straw color; fronds 8–15 inches long, broadly lanceolate, narrower at base than in middle, abruptly terminating at tip, membranaceo-herbaceous, minutely glandular, deep blue-green in color, nearly bipinnate; pinnae remote, short-stalked, obtuse, triangular, ovate to oblong, mostly opposite; segments oblong, obtuse, crenately toothed; sori subterminal on veins, nearer margin than midveins; young indusia subglobose, splitting into several irregular lobes which extend out beyond the sporangia, difficult to detect. September.

Distribution: Vermont to Alabama, westward to Wisconsin and Texas; recorded from Nova Scotia. Moist calcareous or acid soil.

Specimens examined: *Davis, Kellogg, Palmer, Pinkerton.*

WOODWARDIA

1. **Woodwardia areolata** (L.) Moore, Ind. Fil. Gen. 45. 1857. Gray, p. 38; Britton & Brown, ed. 1, 1: 20, ed. 2, 1: 25; Eaton, *pl. 22, fig. 2.*

Lorinseria areolata (L.) Presl in Epim. Bot. 72. 1849.
Acrostichum areolatum L. Sp. Pl. 2: 1069. 1753.
Woodwardia angustifolia J. E. Smith in Mem. Acad. Turin 5: 411. 1793.

Rootstocks creeping, several to 12 inches long, often branched, less than 1/4 inch thick, with some scales near apex; stipes dark at base, paler above, bearing a few scales, dimorphic; sterile fronds 9–10 inches long, oblong-ovate, pinnate, bright green above, paler below; rachis winged from tip to just below base of blades; sinuses rounded, segments acute, 1–4 inches long, 0.5–1 inch wide, finely serrate, membranaceous; veins finely reticulated, with a longitudinal row of narrow areoles along each side of midribs and midveins, and several rows of hexagonal aeroles and free veins running outwards to serrated edges; fertile fronds taller, with a darker stalk; segments and wing of rachis much narrowed; one row of areoles on each side of midribs, each covered by a brown involucre attached to the outer enclosing veins and open along midrib; sporangia also from enclosing veinlets; sterile fronds appearing in May and fertile ones later. August to October.

Distribution: Massachusetts to Florida, westward to Missouri and Texas; recorded from Maine. Swamps and moist soil.

Specimens examined: Poplar Bluff, Butler Co., July, 1898, *Eby*.

EQUISETACEAE

EQUISETUM

1. Stems annual; dimorphic . . . . . . *1. E. arvense*
1. Stems perennial; monomorphic 2
2. Sheaths cylindrical, green, turning gray, with black lines at bases and tops, short and undilated, splitting with age; ridges almost smooth; often very large plants . . . . . . *2. E. praealtum*
2. Sheaths funnel-shaped, green with narrow black limbs, elongate, not splitting; ridges with one row of tubercules; medium-sized plants . . . . . *3. E. laevigatum*

1. **Equisetum arvense** L. Sp. Pl. 2: 1061. 1753. Gray, p. 52; Britton & Brown, ed. 1, 1: 36, ed. 2, 1: 39.

Rootstock tuberiferous, felted with brown wool, extensively creeping; fronds dimorphic; sterile ones annual, prostrate or erect, green, rather slender, 12–24 inches high, 6–19 furrowed, with scattered stomata; sheaths whitish, tipped with about 12 acuminate, brown, separate teeth; branches whorled, simple or compound, not drooping, the 3–4 angled sheaths of branches consisting usually of 4 teeth, or often 3, rarely 5, long and acuminate; fertile fronds annual, appearing in early spring before sterile ones, usually unbranched, succulent, and withering after spores are ripe, 4–10 inches high, light brown, sheaths conspicuous, long, flaring and pointed, of 8–12 teeth; spikes not apiculate; variable. May.

Distribution: Greenland to Alabama, westward to Alaska and California. Sandy soil, in waste places, along streams, etc.

Specimens examined: *Davis, Kellogg, Bush, Daniels, Palmer, Letterman, Eggert, Trelease, Daniels, Mackenzie.*

2. **Equisetum praealtum**[7] Raf. Fl. Ludovic. 13. 1817. Gray, p. 53; Britton & Brown, ed. 1, **1**: 38, ed. 2, **1**: 41.

Equisetum hyemale var. *robustum* A. A. Eaton in Fern Bull. **11**: 74. 1903.

Hippochaete prealta (Raf.) Farwell in Mem. N. Y. Bot. Gard. **6**: 467. 1916.

Equisetum robustum A. Br., Engelm. in Amer. Jour. Sci. **46**: 88. 1844.

Fronds perennial, evergreen, 3–11 feet high, erect; stems rough, 20–48 ridges bearing silica in single rows; sheaths cylindrical, short-appressed, not dilated or only slightly when young,[8] at first green but soon turning black or gray with black bands above and below, splitting with age; sheath segments normally tricarinate; teeth dark and caducous; cones pointed. May.

[7] Schaffner (Am. Fern Jour. **13**: 33–41. 1923), says: "Although perennial, *E. praealtum* usually bears cones on shoots of the season. Shoots sterile the first year may bear cones the second, both terminal and on lateral branches. Branching is rare the first season unless the shoot is injured, but the second year branching is common even on uninjured shoots. *E. praealtum* is an exceedingly variable species, some forms recognized probably being genetic and some ecological, but none of these forms passes out of the specific limits as usually drawn. Some are short and robust; some tall and massive; some very slender."

[8] Young shoots are often very difficult to distinguish from *E. laevigatum.*

Distribution: Quebec to Georgia, westward to British Columbia and New Mexico. Wet sandy places.

Specimens examined: *Davis, Engelmann, Bush, Palmer, Pinkerton, Eggert, Trelease, Daniels, Throuse, Demetrio.*

3. **Equisetum laevigatum** A. Br., Engelm. in Amer. Jour. Sci. **46**: 87. 1844. Gray, p. 53; Britton & Brown, ed. 1, **1**: 38, ed. 2, **1**: 42.

Fronds perennial, erect, mostly simple, pale green, 1–5 feet high, 14–30 ridged, almost smooth, with stomata in two rows on each side of depressions; sheaths funnel-shaped, elongated, and green with usually a narrow black band at the top; white-margined teeth soon deciduous; cones pointed. May to June.

Distribution: New York to North Carolina, westward to Washington and California. Along streams, especially in sandy soil.

Specimens examined: *Engelmann, Bush, Daniels, Eggert, Palmer.*

Osmundaceae

OSMUNDA

1. Sterile fronds truly bipinnate; pinnules stalked and widely separated....... ....*1. O. regalis* var. *spectabilis*
1. Sterile fronds bipinnatifid...2
2. Fronds dimorphic; sterile pinnae with tufts of brown hairs at base; apices of fronds and pinnae tapering; veins inconspicuous............*2. O. cinnamomea*
2. Fronds monomorphic but fertile part of frond is the middle several pairs of pinnae; no tufts of hair at base of pinnae; apices of fronds and pinnae abruptly narrowed and scarcely acute; veins dark-colored, conspicuous. ....*3. O. Claytoniana*

1. **Osmunda regalis** var. **spectabilis** Fernald in Rhodora **32**: 72. 1930. Gray, p. 46; Britton & Brown, ed. 1, **1**: 5, ed. 2, **1**: 7.

Rootstocks stout, creeping, covered with persistent leaf-bases; fronds 2–6 feet high, stipes never chaffy, green or yellow, rounded on back, flattened on front; blades ovate-oblong, bipinnate; pinnae mostly opposite, ovate; pinnules unequal, 6–12 pairs plus the terminal one, subcoriaceous, short-petioled, distant, oval-oblong or oblong-lanceolate, ultimate ones often auriculate on lower side, margins crenulate-serrate, apex obtuse or subacute; apical pinnae fertile, bipinnate,' ultimate divisions thread-like, containing no chlorophyll, entirely covered with sporangia. May to July.

Distribution: Newfoundland to Florida, westward to Saskatchewan and Mississippi. Lowlands, swamps, marshes, and wet woods.

Specimens examined: *Eggert, Palmer, Kellogg, Bush, Pinkerton, Engelmann, Trelease, Mackenzie.*

2. **Osmunda cinnamomea** L. Sp. Pl. **2**: 1066. 1753. Gray, p. 47; Britton & Brown, ed. 1, **1**: 5, ed. 2, **1**: 7.

Rootstocks creeping, massive, bearing circular clusters of sterile leaves with one or more fertile ones within; fronds dimorphic, sterile ones 1 foot or more high, oblong-lanceolate, acuminate, tapering, deeply pinnatifid; pinnae oblong-lanceolate, acute, tapering, tomentose tuft at base of each pinna; pinnules obtuse, subcoriaceous, green; veins inconspicuous, veinlets once-forked near midvein; margins entire or obscurely crenulate; fertile fronds about as tall as the sterile, bipinnate, and covered with cinnamon-colored sporangia, arising early in the spring preceding the sterile ones. May and June.

Distribution: Newfoundland, westward to Minnesota and New Mexico. Sandstone.

Specimens examined: *Eggert, Trelease, Kellogg, Pinkerton, Russell.*

3. **Osmunda Claytoniana** L. Sp. Pl. **2**: 1066. 1753. Gray, p. 46; Britton & Brown, ed. 1, **1**: 6, ed. 2, **1**: 8.

Rootstocks creeping, stout, with imbricated leaf-bases; stipes several inches to 2 feet long, woolly when young but never chaffy; fertile fronds taller than the sterile and in the midst of the crown formation, oblong-lanceolate, 1–4 feet long; lowest pinnae about half as long as middle ones, acute and often rounded; pinnae barely acute, never acuminate, short-stalked, lanceolate from a broad base; pinnules close; 2–6 pairs of fertile pinnae near middle of frond, shorter than sterile pinnae and deflexed in a mature specimen, closely bipinnate, woolly, covered with bivalvular reticulated sporangia. May to July.

Distribution: Newfoundland to North Carolina, westward to Minnesota and Missouri. Swamps and moist woods, moist sandstone ledges.

Specimens examined: *Bush, Eggert, Davis, Palmer.*

Lycopodiaceae

LYCOPODIUM

1. Sporophylls segregated into slender cones; habit of plants fan-like......... ....*3. L. complanatum* var. *flabelliforme*

1. Sporophylls not differing from vegetative leaves; habit of plants rope-like......2
2. All the leaves broadest above the middle; margins jagged......*1. L. lucidulum*
2. Shorter leaves broadest at base; margins entire or slightly denticulate...... ....*2. L. lucidulum* var. *porophilum*

1. **Lycopodium lucidulum** Michx. Fl. Bor. Am. **2**: 284. 1803. Gray, p. 55; Britton & Brown, ed. 1, **1**: 40, ed. 2, **1**: 44.

Stems assurgent from decumbent persistent bases giving rise to a few vertical stems; leaves dark green and shining, widespread or becoming deflexed, acute, broadest above middle, erose-denticulate, arranged in alternating series of long and short members, the latter often entire and usually bearing the sporangia; gemmiferous. August to October.

Distribution: Newfoundland to Delaware, westward to Alaska and Washington. On sandstone only, usually associated with *Sphagnum*.

Specimens examined: *Kellogg, Eggert, Pinkerton.*

2. **Lycopodium lucidulum** var. **porophilum** (Lloyd & Underw.) Clute, Fern Allies, p. 3. 1905. Gray, p. 55; Britton & Brown, ed. 2, **1**: 44.

Lycopodium porophilum Lloyd & Underw. in Bull. Torr. Bot. Club **27**: 150. 1900.

Essentially like *L. lucidulum* except that the shorter leaves are broadest at the base and the margins are nearly smooth, and are not deflexed.

Distribution: in the same places as the species. Sandstone.

Specimens examined: Terre Bleue Cr., Ste. Genevieve Co., coll. of Aug. 29, 1898, *Trelease*, and *Pinkerton 31*.

3. **Lycopodium complanatum** var. **flabelliforme** Fernald in Rhodora **3**: 280. 1901. Gray, p. 57; Britton & Brown, ed. 1, **1**: 43, ed. 2, **1**: 48.

Rhizomes slender, creeping, with numerous erect stems which branch irregularly, giving rise to a flattened fan-shaped vegetative structure, about a foot high with 4-ranked imbricated scale-leaves, those of the two lateral rows broad, with spreading tips, of the upper row narrow and incurved, and of the lower row minute deltoid-cuspidate; peduncles long, dichotomously branched at tips and bearing a number of slender cones about an inch long. August and September.

Distribution: Greenland to West Virginia, westward to Alaska and Idaho. Open pine woods on sandy soil.

Specimens examined: Pickle Springs, Ste. Genevieve Co., *Kellogg 8718.*

SELAGINELLACEAE

SELAGINELLA

1. Plants bearing ill-defined strobili; leaves dimorphic, 4-ranked.......*1. S. apoda*
1. Plants bearing distinct strobili; leaves of one kind, spirally arranged.*2. S. rupestris*

1. **Selaginella apoda** (L.) Fernald in Rhodora **17:** 68. 1915. Gray, p. 58; Britton & Brown, ed. 1, **1:** 45, ed. 2, **1:** 49.

Selaginella apus (L.) Spring in Mart. Fl. Bras. 1^2: 119. 1840.

Stems prostrate and creeping, 1–4 inches long, pale green, delicate; leaves of two kinds, four-ranked and spreading, the smaller pointed and appressed to the stem; no distinct cones; fertile leaves near tip of branches, those containing macrospores conspicuously bulged. July to September.

Distribution: Massachusetts to Florida, westward to Michigan and Louisiana. Moist shaded places, among grasses.

Specimens examined: *Eggert, Bush, Palmer, Mackenzie.*

2. **Selaginella rupestris** (L.) Spring in Mart. Fl. Bras. 1^2: 118. 1840. Gray, p. 57; Britton & Brown, ed. 1, **1:** 44, ed. 2, **1:** 49.

Stems densely tufted, bearing occasional sterile runners; all leaves alike, narrow, appressed, and imbricated, bristle-tipped, gray-green; strobili four-sided. August to October.

Distribution: Quebec to Alabama, westward to Minnesota and Oklahoma. In dry exposed places where there is a little soil, sandstone, or chert.

Specimens examined: *Eggert, Russell, Bush, Palmer, Pinkerton, Greene, Broadhead, VanIngen, Shepard.*

ISOETACEAE

ISOETES

1. Megaspores reticulate; sporangia unmarked ....*1. I. Engelmanni*
1. Megaspores tuberculate; sporangia marked in some way....2
2. Megaspores less than 480 μ in diameter; sporangia marked with brown spots. ....*2. I. melanopoda*
2. Megaspores more than 480 μ in diameter; sporangia marked with brown lines. ....*3. I. Butleri*

1. **Isoetes Engelmanni** A. Br. in Flora **29:** 178. 1846. Gray, p. 61; Britton & Brown, ed. 1, **1:** 48, ed. 2, **1:** 53.

Corms 2-lobed; leaves 15–60, 13–50 cm. long, light green; sto-

mata numerous; peripheral strands variable in number or none; sporangia oblong, unspotted, with narrow velum; megaspores white, 400–570 μ in diameter, distinctly marked with honeycomb network of narrow ridges; microspores 21–30 μ, seldom 33 μ, in length, smooth to minutely roughened.

Distribution: eastern border to Mississippi valley. Near ponds.
Specimens examined: *Engelmann.*

2. **Isoetes melanopoda** Gay and Dur. in Bull. Soc. Bot. Fr. **11**: 102. 1864. Gray, p. 61; Britton & Brown, ed. 1, **1**: 48, ed. 2, **1**: 54.

Corms 2-lobed; leaves 15–60, 15–40 cm. long, slender, erect, firm, bright green, usually black and shining at base, with usually pale membranaceous border, little (2–3 cm.) extended above sporangium level; stomata present; peripheral strands 4–6 cardinal, plus as many as 14 accessory groups; ligule subulate, triangular; sporangia oblong, 0.5–3 cm. long, marked by numerous brown spots; velum variable, from very narrow to covering half of sporangium; megaspores 280–440 μ in diameter, marked with low tubercules, frequently confluent into short low wrinkles; microspores frequently ashy-gray, 20–30 μ long, fine-spinulose.

Distribution: Illinois to Texas. Wet prairies.
Specimens examined: *Pfeiffer, Bush, Palmer.*

3. **Isoetes Butleri** Engelm. in Bot. Gaz. **3**: 1. 1878. Gray, p. 61; Britton & Brown, ed. 1, **1**: 48, ed. 2, **1**: 54.

Corms 2-lobed; leaves 8–30, 8–15 cm. long, more slender and rigid than *I. melanopoda,* tapering to apex; stomata numerous; peripheral strands usually 4, sometimes more in number; ligule elongated, cordate at base; sporangium oblong, 6–7 mm. long, marked with brown lines; velum very narrow; megaspores variable, commonly 480–650 μ in diameter, marked with numerous tubercules, usually distinct, occasionally confluent; microspores 27–37 μ long, papillose.

Distribution: Tennessee, westward to Kansas and Oklahoma. Limestone barrens.
Specimens examined: *Eggert, Bush, Palmer.*

SALVINIACEAE

AZOLLA

1. **Azolla caroliniana** Willd. Sp. Pl. **5**: 541. 1810. Gray, p. 50; Britton & Brown, ed. 1, **1**: 35, ed. 2, **1**: 38.

Plants floating on surface of water, often covering large areas, deltoid or triangular-ovate in outline, 6–25 mm. broad, pinnately branched; lobes ovate, lower lobe reddish, upper greenish with a reddish border; megaspores minutely granulate with three accessory corpuscles; masses of microspores armed with rigid septate processes.

Distribution: Lake Ontario to Florida, westward to Washington and California. On surface of still waters.

Specimens examined: *Eggert, Engelmann, Trelease, Bush, Mackenzie.*

INDEX TO SPECIES[9]

[9] Names in *italics* are synonyms.

Explanation of Plate

PLATE 5

Fig. 1. *Cystopteris bulbifera* var. *horizontalis* Lawson. From *E. J. Palmer No. 32896*, in the Herbarium of the Missouri Botanical Garden.

Fig. 2. *Botrychium obliquum* var. *tenuifolium* (Underw.) Gilbert. From Dr. William Trelease, coll. of October 28, 1897, in the Herbarium of the Missouri Botanical Garden.

NKERTON—FERNS SSOUR

BLASTOMYCOSIS: REPORT OF A CASE, WITH A STUDY OF AN ETIOLOGIC FACTOR AND A CLASSIFICATION OF THE ORGANISM

MORRIS MOORE

Rufus J. Lackland Research Fellow in the Henry Shaw School of Botany of Washington University

Introduction

It is the purpose of this paper to describe briefly the disease known clinically as blastomycosis, and to try to clarify the recognition of the organism involved. The literature of the field is at present too extensive for an entire review, and since numerous workers have already given excellent discussions on the clinical aspects of the infection, as to its gross pathology, microscopic histo-pathology or cellular reactions, and the biological or rather immunological phenomena, a review would be unnecessary here. However numerous such papers may be, there is still much work to be done on the subject.

The author has attempted to clear up, at least in his own mind, several undecided points in the disease: first, the establishment of the etiological agent of blastomycosis; second, the determination of the exact classification of the organism. In the past, and even at the present, medical men have grouped under one general heading all organisms which were responsible for the same clinical condition. Good as this system may be for general diagnosis, much difficulty is encountered because of the fact that physicians are inclined to devote very little time to a study of the organism, thus rendering any therapeutic measures, if available, indefinite, inasmuch as several of the fungi present varying degrees of pathogenicity and require different therapeutic measures.

Thus we find that numerous species of the genera *Saccharomyces*, *Monilia*, *Cryptococcus*, *Endomyces*, *Sporotrichum*, and others have, at one time or another, been considered etiological agents of blastomycosis. A review of the history will illustrate these facts.

History

Years before the first case was definitely described as blastomycosis, investigators had performed a certain amount of work on

fungi involved in cases of infection and had established these organisms as etiological factors, particularly the yeast and yeast-like groups.

Chronologically, the list is quite long, but it is worthy of note. According to Hufschmitt, Sartory, Sartory, and Meyer ('31), we find that in 1845 Remak, and in 1853 Robin, in his 'Histoire Naturelle des Végétaux Parasites de l'Homme et des Animaux,' discovered the normal existence of the yeast *Cryptococcus guttulatus* in the rabbit intestine. A few years previously, Hannover (cited in Buschke and Joseph, '28) had found yeast in the urine of diabetic patients. Investigations then tended to turn to the parasitism of these organisms in animals, with the result that Bernard during the course of his work on fermentations attempted the first animal experiment by injecting beer yeast into these subjects. Following this work, Popoff, Grohe, Roussy, and several others showed the pathogenic actions of the yeasts on mammals, and Rivolta in 1873 in his 'Parasiti Vegetali' demonstrated for the first time a yeast infection in a horse. In the meantime, Metchnikoff and Weismann showed the parasitism of the Saccharomycetaceae in the lower animals. In 1892 Wernicke showed the first mycosis in man and named it "maladie protozoique de la peau." The following year Troisier and Achalme ('93) definitely established the relation between yeasts and man. In the meantime, several workers attempted to show the destructive ability of these organisms on the animal tissues. Popoff in his work had used dogs as his subjects, but impure cultures. Raum ('91) inoculated animals with large amounts of yeasts, and a rise in their temperature, shortness of breath, and death resulted. Neumayer ('91) fed animals with cultures and also inoculated them subepidermally. His feeding developed a gastro-enteritis which he believed due to fermentation, since the skin inoculations were of no value. The yeasts of these workers were probably of the non-pathogenic types, for L. Rabinowitsch ('96), a few years later, showed fifty various yeast-like organisms with seven pathogenic for animals. Nesczadimenko ('99) made peritoneal injections of yeasts in a physiological saline solution into rats, mice, guinea-pigs, and dogs, with death ensuing from eight to twelve days. He concluded, however, that these organisms were not so deadly, although causing this mortality.

The first actual case of blastomycosis, so-called, was reported by Gilchrist at the June, 1894, session of the American Dermatological Association. His paper resulted from the finding of peculiar yeast-like bodies in the diseased tissue of a patient. The doctor attending the patient had given the diagnosis as a typical case of chronic scrofuloderma. Several months after Gilchrist's report, Busse ('94) brought to light the extraordinary case to which he later gave the name "Saccharomycosis hominis." The patient was a woman thirty-one years of age who had suffered from a localized subperiosteal inflammation of the left tibia. An examination of the abscess, which opened spontaneously, revealed "numerous doubly contoured, very refractive, roundish and ovoid bodies," and these were found to be situated both intracellularly and extracellularly in the pus and abscess wall. These organisms when isolated in pure culture and then inoculated experimentally in animals proved to be what were later known to be blastomycetes. The patient later developed superficial ulcers on the face, subperiosteal swellings on the right ulna and the left sixth rib near the axillary line, with death ensuing. Busse cultured the yeast from the ulnar swellings and from the bottom of the ulcers.

Approximately two years later, the first case reported by Gilchrist was published in detail in the Johns Hopkins Hospital Reports of 1896. In the meantime, however, several others had noticed similar cases among guinea-pigs, horses, mice, and other lower animals (Sanfelice, '95, '96, '96a, Roncali, '95, Corselli and Frisco, '95, Tokishige, '96, and others).

In 1896, Curtis isolated a fungus similar to that described by the former writers from a myxomatous tumor of the leg. In the same year, Gilchrist, in conjunction with Stokes, published a short paper on a second case of blastomycosis, and this was published in detail two years later (Gilchrist and Stokes, '98). Simoni ('97), working on the diseased tonsils of patients, found budding yeast-like cells in twenty tonsils. Maffuci and Sirleo ('98) examined numerous tumors and found budding cells in a great number of tissues. Many other reports followed, as that of Hyde, Hektoen, and Bevan ('99) with a supplement by Hektoen ('99) later in the year, Hessler ('99) with a case report, and

several during the same year and 1900. In the following year appeared the elaborate work of Ricketts ('01), with a study of the organism from a case of systemic blastomycosis by Otis and Evans ('03). Eisendrath and Ormsby ('05) described a systemic infection, and Irons and Graham ('06) reported a severe generalized systemic disorder. Hektoen ('07) gave a comprehensive review of the literature, and from that time on the medical journals have published too great a number of cases of infection due to yeast-like organisms, under the heading of blastomycosis, to render a complete survey of literature a matter for a paper of this length.

Etiology and Clinical Manifestations

The disease known clinically as blastomycosis is very likely due to a plurality of organisms and not species of the same genus as indicated by previous writers. This is clearly evident as seen by the great number of papers published and the cases reported, involving such fungi as *Saccharomyces*, *Oidium*, *Monilia*, *Endomyces*, *Cryptococcus*, *Coccidioides*, and even such a form as *Sporotrichum*. The clinicians have referred to the category of blastomycosis any clinico-pathological condition which may be due to yeast-like or budding fungi. It must be understood, therefore, that the term as here used refers only to the clinical aspect of the condition.

In America, clinicians and medical men, more especially medical mycologists, are inclined to class as the cause of blastomycosis only that organism which was described originally by Gilchrist and Stokes in 1894 and in this view the author is greatly in accord. On the other hand, European workers consider only that organism which was reported by Busse ('94) and so elaborated on by Buschke ('98). However, by reason of priority, the organism of the former workers should hold the position so designated and be established as such. Further remarks on the Gilchrist organism will be found in the discussion.

Blastomycosis presents numerous clinical manifestations and in this respect it is protean, being found in practically every organ of the human body either in biopsy or autopsy material. No immunity towards the invading organism is established by any

of the anatomical structures. Clinically, the condition presents lesions which are alike both for the *cutaneous* type of the disease, that is that group of infections which may be found occurring superficially, or for the *systemic* type of the disorder, occurring in the lungs, bones, meninges, liver, or other viscera. This division is based on the work of Jacobson and his associates ('32), who further separate the cutaneous type into that of *primary* in character, as occurring in the epidermic layers or the cutis, as shown by Hagiwara ('22) and Hashimoto ('22), whose organisms, although not of the Gilchrist type yet coming under the general heading of blastomycosis as known clinically, also the work of Grschebin ('27); and *secondary*, due to an infection of the deeper tissues, internal viscera, or bony structures, as shown by Irons and Graham ('06), Ryerson ('09) for bones, and many others.

The *primary* form or the cutis infection Jacobson further designates as presenting one of three varied appearances: papulo-ulcerative; verrucous or papillomatous; gummatous.

The papulo-ulcerative type Jacobson designates as being initial lesions which are papulo-pustular in character and of epidermic origin (shown by Hessler, '99, Hektoen, '99, Ricketts, '01, Engelhardt, '24, and Fabry, '27, '28). These lesions rupture in the course of time and empty out the purulent exudate on the surface of the skin, with the probable ultimate formation of crusts. The process may be proliferative and involve a great area of the immediate vicinity. The lesions usually show a violaceous border with the involution of the peripheral surfaces and perhaps consequent scarring and atrophy.

The verrucous or papillomatous type (Froilano De Mello and Rodrigues, '29) is characterized as being nodular or papular in character and present on a normal or deep-red, infiltrated skin. Several of the lesions may coalesce to form papillomatous patches which resemble verrucous tuberculosis. These lesions may break up into healing areas which upon drying present irregular scars. The characteristic color as noted above is found here too, as well as the sloping periphery.

The gummatous type develops from the subcutaneous layers of the tissue of the deeper portion of the cutis in the form of small,

slightly elevated, somewhat tender, reddish, deep-seated, soft nodules situated on the characteristic violaceous-red surface of the skin. There is a diffusion of the color with subsequent establishment of new nodules in the vicinity. The nodules enlarge, become soft and gummatous, and then break down to form masses of ulcerative, proliferative materials bordered as in the other two types, and contain numerous abscesses.

The *secondary* cutaneous form consists chiefly of variously formed ulcers which give off a purulent or sanguino-purulent discharge from a soft, granulating floor. Some may develop crusts with raised edges, while some may assume hyperplastic functions with papillomatous characteristics, and usually there may be a metastatic action on the part of the ulcers represented by the formation of new lesions which are surrounded by a dark red or purplish zone. Healing may be spontaneous with indurated scars, as noted in some cases, or infection may persist but may finally succumb to treatment with iodides as was noted in the case reported here.

A study of the ulcers formed in blastomycosis shows them to originate in abscesses which from a clinical point of view can be divided into the superficial and the deep types. Secondary, cutaneous, superficial ulcers arise usually in the subcutaneous tissues as nodules of varying size as shown by Stober ('14), Engelhardt ('24), Ferguson ('28), and Montgomery and Ormsby ('08). These ulcers usually enlarge, rupture, and spread the material over the surface of the skin, setting up new foci, or in some cases they have been found to dry up and disappear.

The deep type of secondary cutaneous blastomycosis (Grschebin, '27, '28), characterized by smaller number and deep-seatedness, is by far the most serious of the two, involving destructive processes of the bone, muscle, and deep tissues and organs. It rarely shows any inflammatory reaction, but can be distinguished by the purulent character of the abscesses as contrasted with the mucoid or mucopurulent nature of the superficial abscesses.

The above types represent the typical forms occurring in a clinic. However, Weidman and Douglas ('21) reported the occurrence of a sarcoma-like tumor on the leg of a patient, which

looked like lupus vulgaris and yielded blastomycetoid bodies on histological sectioning. Then, about six years later, Cleland ('27) reported a case with the formation of a myxomatous-looking tumor mass which also showed typical cells on sectioning. These, however, are rare and until more cases are reported cannot be placed in the definite clinical types.

Under the heading of cutaneous blastomycosis, Castellani has also established principal types of blastomycosis of the cutis from a clinical point of view.

1. *Blastomycosis verrucosa* (Synonym: Blastomycosis, Gilchrist type).

Etiology: *Cryptococcus dermatitidis* Gilchrist and Stokes, 1896 (Synonym: *Cryptococcus gilchristi* Vuillemin).

Castellani here creates the genus *Blastomycoides.*

2. *Blastomycosis ulcerativa profunda sen mutilans* (Synonym: Blastomycosis, Wernicke-Ophüls type or Blastomycosis coccidioides type).

Etiology: *Coccidioides immitis* Rixford and Gilchrist, 1896.

3. *Blastomycosis purulenta profunda* (Synonym: Blastomycosis, Busse type; Blastomycosis subcutanea purulenta).

Etiology: *Cryptococcus hominis* Vuillemin, 1901 (probably covers many species).

4. *Blastomycosis glutealis* (Synonym: Blastomycosis, Kartulis type).

Etiology: mycological investigations not yet completed. The fungi seem to belong to the genera *Monilia* and *Cryptococcus.*

5. *Furunculosis blastomycetica cryptococcica* (Folliculitis decalvans cryptococcica, pro parte, Castellani type). (Synonyms: Furunculosis cryptococcica; Pseudofurunculosis blastomycetica; Furunculosis mycetica; Folliculitis decalvans saccharomycetica; Folliculitis decalvans moniliaca).

Etiology: yeast-like fungi either of genus *Cryptococcus* or *Monilia* (No asci or ascospores according to Castellani).

In addition to the above types, Castellani adds the following, although they are in no way connected with the blastomycosis organism: Blastomycosis epidermica; Intertrigo blastomycetica; Dermatitis blastomycetica interdigitalis.

For clinical purposes in diagnosing skin infections such a classification is good, but for correct determination of the etiological agent, it is essential that each type of involvement be named with the infective agent designated as such. For example, if the organism be a saccharomycete, the disease should be called *saccharomycosis;* if a monilia, then *moniliomycosis;* if an endomycete, then *endomycosis.* Thus, when the organism is correctly diagnosed the amount of time necessary to determine the right sort of curative measure for that type of infection may be taken, and the amount of time necessary for healing reduced.

Systemic Blastomycosis

As mentioned previously, the disease is protean in its clinical manifestations, with the result that practically every organ in the body has been shown to be infected either in the living, by various measures, such as X-ray, or in autopsy material. No vital organ is immune, and this in itself is sufficient to cause a careful physician to give more attention to therapeutic measures. This universal infectivity of the agent was especially shown by such writers as Otis and Evans ('03), Eisendrath and Ormsby ('05), Le Count and Myers ('05), Irons and Graham ('06), Montgomery and Ormsby ('08), Wade and Bell ('16), Garr ('25), Panja ('25), Toepel ('29), and Maner and Hammack ('30). There is, however, a difference in frequency with which the various organs show their susceptibility.

The portion of the anatomy that shows the greatest amount of infection is the skin, either primary or secondary, having about 95 per cent of all cases recorded. This phase of blastomycosis has received the greatest amount of attention principally because it is so prevalent, but also because it is usually a manifestation of a metastasis from the deeper organs, and this helps bring forth the diagnosis of blastomycosis.

The pulmonary system, including the lungs and bronchi, constitutes the second most frequent and the most common systemic form, being present to the extent of approximately 95 per cent in systemic infection in available autopsy records, and about 35 per cent in primary cases. This was shown by such men as Stober ('14), Wade and Bell ('16), Wade ('18), Dennis ('18), Miller ('27), Medlar ('27), and Mazza and Niño ('28). The disease probably is primary in the bronchi and from there spreads to the lungs. If secondary in the lungs, as in systemic disorders, the process may be slow and chronic; if primary, however, the spread may be rapid and fatal.

The kidneys are next in frequency of infection. The genitourinary involvement is usually secondary by way of metastatic foci through the blood. The disease in these organs manifests itself in the form of nephritis, showing casts and albumen in the urine. The culturability of the organism from samples, however,

cannot be demonstrated unless the kidneys are accompanied by infected bladder or prostates.

The spleen follows next in order, but this organ is usually easily susceptible so that a great amount of infection is to be expected in any systemic disorder of this sort.

The complication of the bones and joints seems next in the amount of infection. This form of the syndrome is very common in systemic disorders, and may even be a primary infection if the diagnosis in the patient here described was correct seven years previous to his entry at the Barnard Skin and Cancer Hospital. This type of the disease may manifest itself in the form of arthritis, osteitis, osteomyelitis, or periostitis, according to Ryerson ('08–'09) and Stober ('14). The process usually results in a suppuration, formation of sequestra, and abscesses which break down intervening cell walls and coalesce, causing great damage.

The liver appears to be a rather frequent subject to the infection, coming next in the order of frequency. This is to be expected in systemic disorders where the blood plays an important part. Metastases through the blood vessels are fairly common, and yeast cells are easily transported to the main organs in this manner.

The pleura too are susceptible to a great extent, and here the proximity to the lungs is a great factor in their infection.

The lymph glands follow along rather closely, as shown by Wanamaker ('28), especially for the cervical lymph glands.

Cerebrospinal involvement, including the brain, meninges, spinal cord, and skull bones, occurs fairly often as a secondary metastatic process in generalized systemic blastomycosis, according to studies made (J. T. Moore, '20, Freeman and Weidman, '23, Greenfield, '24, Wilhelmj, '25, and Gáspár, '29), being found in at least 12 per cent of the cases. When the disease is secondary to a general systemic infection, there may be osteomyelitis of the skull bones with destructive processes. The diagnosis rests not upon any clinical entities which may be present, because the inflammatory reaction simulates many other conditions, but upon the actual laboratory finding of the organism either in the spinal fluid or in sections of the diseased brain tissue.

Wilhelmj ('25) states that in those cases where there is no pathological symptomatology or clinical manifestation on any other part of the body, and when the meninges are infected during the primary stages of the invasion, death may occur without the initial appearance of general metastatic foci, and such a condition he calls primary cerebrospinal blastomycosis. The spine may be involved in the process in a suppurating condition (Parker, '23), but this condition is relatively rare.

Jacobson lists the vertebrae as being next to the brain in susceptibility to attack. This condition has been noted on several occasions. Roentgenographic studies usually reveal an infection of bodies of the vertebrae, and lamina and posterior ligaments may show an involvement which simulates greatly tuberculous Pott's disease.

Prostatic infection in blastomycosis is often noticed (Parmenter and Simpson, '19). Usually it is associated with a genito-urinary complication and involves the urinary bladder (Rhamy, '26). In these cases acute urinary urgency and pyuria are well-defined symptoms.

The heart lesions in blastomycosis are shown first in the pericardium and then in the myocardium in the form of an inflammatory reaction (Hurley, '16).

Pancreatic involvement follows in frequency.

Infection in the peritoneum is the next most common. Jacobson reports finding the disease in the abdominal viscera in the following decreasing order of frequency: kidneys, spleen, liver, lymph glands, pancreas, peritoneum, adrenals, and gastrointestinal tract. These organs, as pointed out previously, become involved usually through metastasis by way of the blood stream or by direct transmission from tissue to tissue. In this manner, testicular blastomycosis is usually developed. Blanchard, Swartz and Binot ('03), as early as 1903, noted an intraperitoneal involvement.

The eyes may also be involved. The infection here is very painful and often dangerous, leading to blindness with perhaps a complication of the nervous system and the brain. McKee ('26) and Ferguson ('28) noted cases of the eye which were secondary infections due to a metastasis from the pulmonary apparatus.

Laryngeal and tracheal blastomycosis are rare infections. Jacobson records four in America and one in Europe. All the patients were adult males working either with the soil or its products, one being a clerk in a general store (Dennis,' 18, Downing, '18, C. Jackson, '26, and New, '28). The larynx showed a "chronic inflammatory mucosa with a grayish, minutely nodular surface in some portion of the lesion, with a few minute, isolated, yellowish nodules." There was often a reddish, raw portion of the larynx due to the ease with which the superficial layers came off with coughing. The process resembled very closely tuberculosis.

Involvement of the tongue is perhaps a rare occurrence, but cases are not reported in great numbers purely because sputa smears usually show a variety of yeasts and thus no definite etiological significance is attached to those obtained. The first case was reported by Copelli ('13), a second one by New ('17) from the Mayo Clinic. Since that time, however, Mazza and Canevari ('29) reported a case from Argentina, and Niño ('29) reported an infection of the lower lip with the involvement of the tongue. Such an infection usually hinders respiration, inasmuch as a tumor-like growth, as evidenced by Copelli and New, developed which enlarged in the back portion of the tongue and practically filled the entire larynx.

Symptomatology

Blastomycosis when of the primary cutaneous type presents no clinical symptomatology of discomfort or pain except for that expressed because of the lesions. When of the systemic type, however, the condition is very different. There are numerous clinical factors to make a picture which might easily be confused with a number of diseases.

According to numerous investigators, the onset of the disease varies with the person and amount of infection. It may be intense and acute, leading to death in a short time, or insidious and mild, with a prolonged chronic condition, death finally occurring as a result of a secondary complication. There is a typical set of symptoms once the disease is well established. This consists of typical malaise, recurrent chills, loss of weight,

as evidenced in the present case, loss of strength leading to general emaciation, night sweats, although morning sweats may be present too, irregular fever, pain in affected parts, and a rapid pulse.

The disease, as noted before, may be primary in the skin with subsequent spread systemically or it may be systemic with the formation in the later stages of nodular growths on the skin. Unless the patient is well taken care of, systemic infection results, leading ultimately to death.

Differential Diagnosis

The final diagnosis of blastomycosis rests on the finding of the organism either culturally in a lesion of the patient or, if that be unavailable as in systemic disorders, the identification of the fungus in biopsy or autopsy material.

As pointed out previously, the disease is protean in character, with the result that a careful examination must be made to diagnose it blastomycosis, comparing it with the several well-known clinico-pathological entities which it may simulate. The most noteworthy of these complicating diseases are as follows: (a) The dermic lesions described previously, developing necrotic and papillomatous growths or ulcers, resemble very closely epitheliomas, differing only in the rapidity of evolution and the absence of deep induration, verrucas, tuberculosis in its various forms, and syphilis. Its resemblance to sporotrichosis (Lewis, '17) has often been noted, but it differs in being less sluggish. It differs from syphilis only by the softness of the lesions, the reddish-blue ring around the lesion, and by a negative Wassermann, with, of course, the presence of the organism in the blastomycosis infection; (b) The systemic infections of blastomycosis must be distinguished through laboratory methods from a great many complications, particularly coccidioidal granuloma described in a previous paper by the author (M. Moore, '32). The organism of coccidioidal granuloma, *Coccidioides immitis*, reproduces by endosporulation, and the blastomycosis organism, through budding. Furthermore, the lesions in the so-called "California disease" are more rapid in evolution than in blastomycosis; (c) Infection of the glands which is quite rare in blastomycosis often suggests

lymphatic leukemia, Hodgkin's disease, and possibly lymphosarcoma; (d) Gastro-intestinal lesions may often resemble typhoid and in some cases the isolation of the organism is necessary to rule out this disease; (e) Osseous infection quite often resembles tuberculosis, particularly as reported by Ryerson ('08–'09); (f) Pulmonary blastomycosis very often presents the same clinical, histological, and pathological pictures as tuberculosis, as noted by Medlar ('27) and Miller ('27); (g) Infections of the brain often confuse the pathologist or clinician with its similarity to torula (Freeman and Weidman, '23), epidemic meningitis, and even tumors of the spinal cord; (h) Sutejew, Utenkow, and Zeitlin ('29) find that the use of bromides and iodides evidently causes an allergy which in its reactions presents lesions similar to those caused by the infective agent of blastomycosis and is often confused with it, the latter differing in their more rapid evolution.

It would seem, therefore, that the recognition of blastomycosis is not a very easy matter. The really important fact concerned with this work is to find the organism, which usually requires laboratory technique, and to verify its pathogenicity by animal inoculation in order to comply with Koch's postulates.

Predisposing factors.—The infective agent shows no particular preference as to sex, although more cases have been males than females, of the industrial classes, chiefly the workers of the soil and its products, a fact well exemplified in the present case. There is no discrimination as to race or color, all peoples being affected in like fashion. Stober ('14) correlates the type and amount of infection with the habitat and environment of the patient. As far as is known, all ages are susceptible, a similar condition existing for many other fungi which tend to become systemic, such as coccidioidal granuloma.

Treatment.—The successful therapeutic measures in blastomycosis are few and limited. The best treatment or cure for the disease rests of course on the skill of the physician in detecting it at an early stage before it has seized a definite foothold, when it can be kept from becoming systemic. If the disease is definitely located in a particular section, surgery may be used to eliminate it, as suggested by several authors (Wade and Bell, '16, R. H.

Jackson, '26). Cautery has also been used with beneficial results. Hedge ('28) has employed carbon dioxide snow in freezing cutaneous lesions with measurable success. X-ray treatment has also been used frequently, being combined with the administration of iodides. On the whole, primary cutaneous lesions yield fairly readily to iodides and even the application of crystal violet and gentian violet, although their use if at all successful is empirical because dye therapy does not rest on any scientific basis (Spring, '29).

In systemic infections, however, one has to contend with complications. The extent of the infection cannot be determined easily. The only cases to recover from an infection of this sort are those to which special care and attention coupled with a change to a clean, pure atmosphere had been made, with the administration of large amounts of saturated iodide solution, either potassium or sodium, although the former has been used more extensively. The dyes mentioned above have proven worthless to the systemic type of disorder. Several workers have advocated copper sulphate, but many others have found this to be useless. Roentgenotherapy has, as yet, no really therapeutic importance. Stober has applied immuno-therapy in the form of a vaccine of suspended blastomycotic cells, heated to 110° C., but no definite results can be shown.

It would seem, therefore, that therapeusis is greatly in need of investigation.

Immunological reactions.—Immunology in blastomycosis has not reached any definite point as yet. Agglutinins have been reported by some, and negative results by others. Precipitins have also had the same reaction, as well as complement fixation. On the whole, results are indefinite and a good deal more information is needed. The main difficulty seems to be that the toxins of the blastomycosis fungus are difficult to demonstrate. So far, immunology is an open book with only attempts proving nothing written on its pages, and it is to be hoped that more work can be done along this line for the benefit of those who may be inflicted with this syndrome-complex.

Mortality.—The number of deaths resulting from blastomycosis is a factor worthy of note, since systemic disorders due to the

typical blastomycotic organism usually prove fatal. This is so because systemic infections are rarely diagnosed as such until there have been cutaneous outbreaks, with the result that therapeutic measures are given too late for beneficial results. It is difficult to quote figures because there are many cases occurring which have rapid recovery and the physician does not report them. Moreover, true blastomycosis is difficult to diagnose unless smears and cultures are made from the abscesses. In many instances, several attempts are necessary before any fungous growth is obtained, and unless the investigator is well trained in mycological technique and in the recognition of such forms typical of the Gilchrist organism the application of Koch's postulates would be essential, particularly with mice and guinea-pigs.

Report of Case

Clinical History.—M. H. L. (Hospital No. 50095), a white, widowed male, farmer by occupation, 43 years of age entered the Barnard Free Skin and Cancer Hospital, at Saint Louis, Missouri, April 5, 1932, with an ulcerating, proliferating infection of the left hand and forearm, which the patient claims to have had for 5 years.

Family History.—Father died as a result of high blood pressure, hypertension, at age of 56 years. Mother dead due to throat trouble, at age of 30 years. Three brothers and one sister dead due to an infancy cause. Patient has 7 children, all living and well. Wife dead due to double pneumonia at age of 38 years. No history of diabetes, nephritis, syphilis, or cancer in family.

Past History.—Past health has been good; usual childhood diseases. He had pneumonia at 15 years of age, bronchial pneumonia at 18 years of age, and influenza in 1918. He has had no operations other than those to be mentioned in the present illness. Right leg injured 7 years ago.

Personal History.—Patient denied any venereal disease.

Present Illness.—Patient stated that 7 years previously, a limb had fallen on his right lower leg, causing a knot to form. The physician who examined his leg thought he had a periostitis and opened the lesion on the leg. About 2 years later, or 5 years previous to entering the hospital, a mossy, verrucous-like lesion similar to that on the leg appeared on the back of the left hand. Both the lesions on the right lower leg and on the hand continued to spread. The patient went to the Vanderbilt University Hospital, at Nashville, Tennessee, about a year later, at which time the eruption had spread over most of the anterior and lateral sides of the right lower leg with two lesions of the right thigh above the right knee and with involvement with most of the back of the left hand and part of the forearm. He remained in the Vanderbilt Hospital for about 3 months, during which time the lesions on the right leg and arm were curetted and treated with X-ray. At the time of his discharge, the lesions on his right leg had healed, as had most of the hand except that portion near the thumb and the wrist. Another currettement was performed, but the lesion persisted. He received two X-ray treatments each on the leg, arm, and hand. Six years previous to entering the Barnard, he had lesions on the right elbow region;

these lesions healed. About 4 to 6 years before his entry he had lost some weight, but at the present time complains of no recent loss of weight. He gives no history of hemaptysis, night sweats, fever, or frequent colds. About 10 days previous to entry, a reddish lump developed on the flexor surface of the left lower arm near the elbow. This lump is not very tender or painful. He has been applying potash on the ulcerated area of the left hand.

Physical Examination.—Patient is a thin, coöperative, moderately active, white male 43 years of age, who has had the condition herein to be described as blastomycosis of the left arm and hand for approximately 6 years and who had the same condition on the leg for 3 years until it was curetted and X-rayed 4 years previously. The right leg and left arm show scarring which will be described later.

Head.—Normal size and shape.

Eyes.—Eyes react to light and accommodation. Reactions normal.

Ears.—No discharge, apparently normal.

Nose.—Septum intact, no ulcers.

Throat.—Slight redness.

Mouth.—Several teeth missing.

Neck.—No stiffness or rigidity; tonsillar and cervical glands palpable.

Thorax.—Thorax hairy, thin, and symmetrical; expansion fair.

Lungs.—Breath sounds a little harsh and rough over both lungs, principally the right and right apex. Voice sounds normal, but louder on the right than on the left. No persistent or moist râles or râles heard after coughing. Expansion and resonance normal.

Cardiac.—Cardiac sounds a little slow and distant, but of a normal quality. No enlargement or pathological murmur. Blood pressure, 106 systolic and 66 diastolic.

Abdomen.—No masses or tenderness. Inguinal glands a little enlarged.

Genitalia.—Normal male; no discharge or penile sores.

Reflexes.—Superficial—present and active. Babinski negative. Deep—present and active.

Extremities.—Left arm and hand—The lower third of the left forearm, back of the hand and extending 2 or 3 cm. on to the palm, is involved in an atrophic process sharply defined superiorly and inferiorly with some scaling, no telangiectasis. On the external surface of the forearm extending on to adjoining parts of the hand and thumb is an ulcerative process which has been covered with a black crust. Ulcerated area of the left thumb and the flexor surface of the left forearm consists of warty-like and cone-like, multiple abscesses with some elevation of the borders. There is a deep scar on the right elbow region. The anterior, medial, and lateral aspects of the right lower leg are covered with a thin, smooth scar about 12 to 14 inches long and covering two-thirds of the right lower leg. There are two scars just above the right knee, about 4 inches, and 8 × 4 inches in diameter, respectively.

On the flexor surface of the left forearm, just below the elbow, is an abscess which is red in color, oval in shape, semifluctuant, practically non-tender and not hot. Extending up from and about the abscess is a chin of firm lymph nodes. The lymph nodes above the left elbow and epitrochlear region are a little enlarged.

Laboratory Findings.—Urine negative, being pale straw in color and clear. Blood tests showed 4,600,000 red blood cells and 10,200 white blood cells, with 84 per cent hemoglobin. The differential blood count showed 26 lymphocytes, 8 large mononuclears and transitionals, 156 polynuclear neutrophiles, 2 polymorphonuclear eosinophiles, and 2 basophiles. Wassermann negative. Smears from the left hand and

arm showed budding forms of yeast cells on April 7, 1932. Blood, urine, and pus from left hand and lower arm and pus withdrawn from abscess of left arm were inoculated on glucose-glycerine agar on April 8. Spinal puncture on April 12 showed a clear fluid with a normal pressure. Glucose-glycerine agar and blood agar were inoculated with spinal fluid, with no growth occurring.

April 9, 1932.—The patient was started on potassium iodide with dosage up till signs of intoxication, and an ointment saturated with gentian violet was applied locally. This treatment was followed with 10 per cent sodium iodide intravenously for several days when patient showed an improvement.

April 16, 1932.—X-ray of left forearm and wrist, right femur, and right leg showed no abnormal bone changes. The hilar and bronchial structures of both lungs showed considerable thickening, inflammatory in character, but the parenchymatous portion of both lungs appeared free from any active pathology.

July 7, 1932.—Patient showed a very marked improvement, with still some evidence of trouble around the left thumb.

Clinical Diagnosis.—Blastomycosis of left hand and arm.

The agar inoculated from the left arm developed a culture which went through the three stages typical of the organism of blastomycosis: the yeast-like growth; the prickly type of growth; and the cottony type of growth. This culture was used for the studies carried out in this paper.

Animal Inoculation

A suspension of a 10-day-old culture of the organism in sterile saline was inoculated in a mouse, intratesticularly. An orchitis developed and the mouse showed typical malaise, emaciation, loss of appetite, loss of weight, rise in temperature, with death ensuing in three weeks. The internal viscera showed numerous, pin-point lesions at autopsy, which when squeezed exuded a muco-purulent material from which the yeast cells were isolated. This was in accordance with Koch's postulates.

Technique

In order to ascertain the morphological characteristics of the fungus, the organism was suspended in hanging-drop cultures, allowed to grow, and observations made from time to time. For finer detail and structure, several transfers were made to slides on which had been placed a drop of a mixture of glycerine (Merck C. P.) and a 1 per cent solution of crystal violet. The fungus was allowed to remain for a period of one-half to one hour to allow for a clearing of the material and sufficient staining to render satisfactory results. This method proved adequate for the work here described. Another method was used also, whereby material was fixed on a slide smeared with albumin and then stained with

methylene blue and eosine. The first method, however, was sufficient.

DESCRIPTION

A study of the organism in lesions reveals a yeast-like growth of spherical or ovoid, budding and branching cells with no evidence of any filamentous hyphae. These cells, measuring approximately 7–12 μ in diameter and sometimes as much as 20 μ in length, may occur singly, in groups of two's, three's or four's, as individual colonies. On closer examination microscopically, these yeast-like cells (pl. 6, figs. 1–9) show a heavy, reticulated, granular, and in many cases, vacuolated, protoplasm, and a very definite nucleus with emanating streams of cytoplasm. In many cells the nucleus is barely distinguishable, being a mass of cytoplasmic structures, but further study after several subcultures shows up this part of the cell very frequently. Many of the yeasts of this group may show a double-contoured, highly refractile membrane, and this feature is of little diagnostic use unless demonstrated in tissue sections, as by Rewbridge, Dodge, and Ayers ('29) for *Endomyces capsulatus*, and by Moore (McBride and Thompson, '33) for *E. capsulatus* var. *isabellinus*. Thus Wade ('16) ascribes to the fungus structure in tissues: (1) an inner delicate *capsula vera;* and (2) an outer applied *capsula sclerotica.* In any case, the capsule is lost on repeated cultivation on artificial media.

With agar as a substrate, the yeast-like cells elongate (pl. 6, figs. 10–12, 14–17) and on acid media become thin-walled and long with a diameter of 2–2½ μ. These hyphae become intertwined and are composed chiefly of isodiametric cells. On neutral or slightly alkaline media, with protein as the chief source of nitrogen, the hyphae are thicker and shorter, with a diameter of 3–4 μ. This condition is especially true of media with an excess of carbohydrate as found in glycerine agar.

Budding cells are numerous on slightly acid media, being about 5 μ in diameter (pl. 6, figs. 26 and 28).

The hyphae, at first clear, become granular, and at various points along the sides develop numerous small, knob-like projections of the limiting membrane, which enlarge, round out or become pyriform and sessile, measure approximately 5 μ in

diameter, and occur usually near a septum. These are known as conidia and may remain attached, at times to small stems or sterigmata, or may become free and develop in the media by budding (pl. 6, figs. 24, 26, 28–29).

Racquet mycelium (pl. 6, figs. 23–24), a phenomenon characteristic of the fungi of this group and especially of the Trichophytons and various other Ascomycetes, is common here, having the swollen portion 5–6 μ in diameter and the narrow section 3–3½ μ in diameter. Chlamydospores may be found arising in the hyphae or terminal as hypnospores, varying in size and shape from round cells 7–8½ μ in diameter, to elongated, widened cells 5½–7½ μ wide and 12–15 μ long (pl. 6, figs. 22, 25, 27–29, 31, 32, and 37), or they may arise as sessile cells from the hyphae (pl. 6, fig. 36). Round, thick cells with a coarse, granular cytoplasm are particularly evident on cornmeal agar (pl. 6, figs. 26 and 28).

When first examined in a hanging-drop preparation, one may see oil droplets on the hyphae which are strongly suggestive of endospores. These disappear, however, when the organism is stained. In some cases, as in pl. 6, fig. 25, a hollow sphere or vacuole surrounded by a hyaline, gelatinous substance may be present in the filament.

The development in tissue, as has been noted, is chiefly by budding or gemmation. The process begins with the projection of the inner layer of the cell or endosporium, following Hektoen, which pushes the transparent zone and outer membrane in front of it. The bud becomes enlarged and surrounded by the same walls as surround the mother cell, and division takes place by the presence of a cross-wall which is formed by the pinching in of the cell (pl. 6, figs. 1–3, 6–7). On artificial media, on the other hand, proliferation of the fungus is brought about through sexual reproduction which is heterogamous. Two terminal cells may fuse (pl. 6, fig. 19) or two hyphae growing side by side may send out lateral cells which copulate (pl. 6, fig. 18). In either case, a spherical ascus results which may be terminal on a long filament or lateral on a short peduncle (pl. 6, fig. 33) and has a thick capsule (pl. 6, figs. 21 and 33), sometimes surrounded by a sheath as in pl. 6, fig. 35. The latter case, however, is rare and was

observed only three times. There are formed 8 spherical to ovoid, smooth spores which are hyaline when young and held in a gelatinous substance and when older become chamois-colored and granular, and have at maturity a diameter of 2–3 μ, varying on different media (pl. 6, figs. 38 and 33).

This organism therefore agrees with that described by Gilchrist and Stokes as *Blastomyces dermatitidis*, but further observation has here been made on the sexual development.

Cultural Descriptions

The culture in this case was growing on glucose-glycerine agar, being an inoculum from an abscess on the left arm. All cultures used in the cultural determinations were taken from the above tube and grown at room temperature, approximately 22° C.

Having the two stages so common with yeast-like organisms and characteristic of several members of the Endomycetales, it was thought desirable to transfer the fungus on a wide variety of media and pH range. Possessed with saccharomycetous properties, on the one hand, and filamentous fungous affinities, on the other, the above method of culturing proved to be satisfactory in this work.

The following media used are arranged in the order of decreasing hydrogen-ion concentration.

Raulin's Solution (pH 4.1).—Culture shows a thin, smooth suspension of yeast-like cells, budding and branching, varying in size from 4½–5½ μ x 7–8½ μ, with several showing a change to filamentous formation.

Richards' Solution Agar (Media consisting of Richards' solution with the addition of 1.5 per cent agar. pH 4.4).—Growth sparse, of fine filaments. Colony 3½ cm. in diameter at end of 30 days. Culture shows long hyphae projecting from edge of growth, 2½–3 μ in diameter, with numerous budding cells. Filaments branching, with cross-walls, numerous chlamydospores, and swellings. Characteristics of the group present. Color of colony isabella to cinnamon, strongly suggestive of chamois, due to the spores and asci which are in abundance.

Czapek's Agar (pH 4.4).—Color of colony white, becoming chamois with age. Growth very sparse and cottony, with much

of the mycelium submerged in the agar. Colony 4 cm. in diameter at end of 24 days. Hyphae long and thin, 1½–2 μ in diameter, with swellings approximately 4 x 12 μ, several thick-walled chlamydospores 7½ x 14 μ, and numerous terminal hypnospores. Several 8-spored asci seen, as well as many conidia.

Malt Extract Agar (pH 5.3).—Growth slow and cultural characteristics insufficiently different to be taken into discussion.

Sabouraud's Agar (pH 5.6).— Growth rapid, profuse, obtaining a diameter of 7½ cm. at end of 30 days. Culturally the colony simulates very much that of *Microsporon audouini* of Ota and Langeron in the presence of several radiating ridges from the round center, the inoculum, and the several concentric rings of growth of decreasing abundance, just outside the ridges. Color of colony white when young and becoming the characteristic chamois when older. Like *M. audouini*, it has racquet mycelium, chains of round cells on a hypha measuring 3½ μ in diameter, numerous chlamydospores 8 x 12 μ, terminal hypnospores 5 x 11 μ, and many conidia, characters found also in the Trichophytons and peculiar to *Endomyces capsulatus*. Unlike *M. audouini*, however, this organism reproduces by the formation of asci which are numerous here, measuring from 10 to 13 μ in diameter, containing 8 spores.

Sabouraud's Broth (Sabouraud's medium minus the agar. pH 5.6).—Culture consists of submerged mycelium of large flakes, each measuring approximately 2 cm. in diameter at end of 24 days. Mycelium floating on surface, dry, and chamois colored, with white region, presumably the young hyphal elements. In general, growth is good. Microscopically, the culture shows long, narrow hyphae 2½ μ in diameter, branching and intertwining. Submerged mycelium shows almost no swellings, chlamydospores, terminal hypnospores, nor thick-walled cells, as compared with the great number found in that on the surface. The several that are present, however, show a great reduction in size and form from the exposed, the measurements of which are similar to those on agar.

Potato-dextrose Agar (pH 5.6).—Growth profuse and cottony, covering the surface of the agar completely. Diameter of colony

7½ cm. after 24 days. Color cinnamon, with colony showing concentric circles of color alternating with white, and the cinnamon very pronounced, due perhaps to the medium constituents. Hyphae 3 μ in diameter, with numerous, thick-walled cells 7½ μ in diameter, budding cells, swellings 5 x 12 μ, and chlamydospores varying in size from 4–7 x 9–14 μ. Asci numerous, measuring approximately 13 μ in diameter.

Corn-meal Agar (product of Digestive Ferments Co. pH 6.0).—Growth poor, colony being 1½ cm. in diameter at end of 24 days. Color white. Growth around inoculum loose and cottony. Hyphae short, thick-walled, 2½ μ in diameter, with numerous budding cells approximately 7 μ in diameter. Chlamydospores numerous, 7 x 13 μ, terminal hypnospores several, 5 x 12 μ; a few asci seen, 11 μ in diameter. Conidia abundant, 5 μ in diameter.

June-beetle Agar (medium consisting of a 4 per cent extract of June beetles, Lachnosterna fusca, plus 1.5 per cent agar, sterilized at 20 pounds pressure for 20 minutes, with a final pH 6.1).—Growth of loose, flat, cottony mycelium, forming concentric circles of decreasing abundance until a ring of fine filaments surrounds the culture. Colony 5½ cm. in diameter at end of 24 days. Hyphae 2–2½ μ in diameter, with many conidia 5 μ in diameter. Asci 12–13 μ in diameter, thick-walled, enclosed in a sheath. Abundance of racquet mycelium.

June-beetle Dextrose Agar (above medium plus 2 per cent dextrose).—Growth fair, attaining a diameter of 3 cm. at end of 30 days. Colony bright chamois in color, cerebriform, and cottony. Many conidia, 4½–5 μ in diameter. Hyphae 2½–3 μ in diameter and fairly short. Chlamydospores 8 x 16 μ and numerous, as well as terminal hypnospores 5 x 12 μ. Asci round, 12–14 μ in diameter.

Lactose Agar (product of Digestive Ferments Co., lactose broth plus 1.5 per cent agar. pH 6.8).—Growth good, reaching a diameter of 6 cm. at end of 24 days. Colony chamois-color, profuse and cottony, with a region of very fine mycelium surrounding it. Hyphae 3½ μ in diameter with numerous conidia 5 μ in diameter, budding off. Many thick-walled resting cells 7 μ in diameter. Characteristic racquet mycelium, chlamydospores, terminal hypnospores, with properties similar to those on Sabouraud's agar.

Lactose Broth (*product of Digestive Ferments Co. pH 6.8*).—Growth good, large white flakes being formed in the solution which later become intertwined, forming a mat of mycelium 7 μ in diameter. Hyphae slightly reduced, 3 μ in diameter, 1½ μ in the younger filaments. Preponderance of budding cells 7 μ in diameter, with thick-walled chlamydospores, asci, and terminal hypnospores, but reduced in size as compared with the growth on agar.

Eosine-methylene-blue Agar (*agar used as one of a routine, product of Digestive Ferments Co. pH 7.0*).—Growth good, with a diameter of 5½ cm. at end of 24 days. Culture compact, due to the hyphae having absorbed the stain from the substrate and turning the mycelium pink. Colony appears powdery with age. Hyphae characteristic, with swellings, 3 μ in diameter. Many conidia, 5 μ in diameter, and hypnospores with several chlamydospores.

Glycerine Agar (*nutrient agar as prepared by the Digestive Ferments Co. plus 6 per cent glycerine, Merck C. P. pH 7.1*).—Growth fair, having a diameter of 5 cm. at end of 24 days. Culture shows a crinkled, moist region of budding yeast-like cells and a dry filamentous, cottony, chamois-colored region which has changed to the mycelial form characteristic on agar. Filamentous hyphae 3½ μ in diameter, characteristic swellings being present which are slightly larger than those found on lactose agar. Racquet mycelium also present.

Nutrient Agar (*product of Digestive Ferments Co. pH 7.2*).—Growth rapid, covering a region 7 cm. in diameter at end of 30 days. Colony filamentous, cottony, brown, with concentric rings of growth, the outermost being white. Hyphae 2½ μ in diameter. Growth similar to that on Sabouraud's agar microscopically, with numerous conidia 5 μ in diameter and asci 13 μ in diameter.

Nutrient Broth (*pH 7.2*).—Culture forms a mat of intertwining mycelium of long hyphae 2–2½ μ in diameter, with swellings, asci, and chlamydospores. Very few conidia. Terminal hypnospores several, but reduced in size, 4 x 9 μ.

Endo's Agar (*product of Digestive Ferments Co. pH 7.5*).—Growth fair, colony having a diameter of 3½ cm. at end of 30

days. Culture shows radiating ridges from center of inoculum, with growth becoming flat due to the stain in the medium which is absorbed by the hyphae, as in the case of the eosine-methylene-blue agar, giving the mycelium a pink color. Microscopically, the hyphae have a diameter of 2½ μ. Numerous conidia 5 μ in diameter. Culture otherwise similar to that on eosine-methylene-blue agar.

Gelatine (*nutrient agar plus 1.5 per cent gelatine*).—Slow liquefaction beginning after 30 days.

Culturally, the fungus is very characteristic of the organism of blastomycosis in that it passes through the three typical stages: the moist, yeast-like stage with a flat growth; the prickly culture with the colonies simulating greatly small burrs (coremia); and the final, cottony growth present on agar after extended growth.

Discussion

As stated in the introduction of this paper, it would seem that the syndrome-complex, commonly known as blastomycosis, has an innumerable list of etiological factors, each causing a condition so much like the other that clinicians have grouped them under one head. However, should one encounter any of these in a clinic one would find that therapeutic measures are so vastly different, varying with the organism, that a direct and accurate knowledge of the causative agent in each particular patient is absolutely essential.

In the past, medical men, not particularly trained in mycological taxonomy, were inclined to class together all fungi presenting ascomycetous characters under one name, *Blastomyces*. So great is the confusion to-day that it is necessary to pick out these pathogenic fungi and classify each one separately.

The organism isolated in the first case was termed *Blastomyces dermatitidis* by Gilchrist in 1894 because of its budding properties in the lesion. In a case of dermatitis reported by Gilchrist and Stokes ('96) the organism, which was evidently of the type termed *Blastomyces*, was called an *Oidium*. In a following paper (Gilchrist and Stokes, '98), it was made known that the organism described in the previous paper was called an *Oidium* because it did not ferment glucose, saccharose, or lactose, and although

developing by gemmation or budding in the tissues, human and animal, developed mycelia with the formation of conidia upon artificial media. Ricketts ('01) made an extensive study of the organism, distinguishing it from several of the yeasts but failing to consider several of the yeast-like fungi, and proposed definitely the name *Oidium* for the genus of the Gilchrist fungus. After this work, several terms were applied to the disease. Busse ('94) described his case a short time after Gilchrist reported his and he named the organism *Saccharomyces hominis*. Vuillemin in a later publication assigned the organism to the genus *Cryptococcus* and called it *C. gilchristi*. However, he failed to make a careful study of the organism culturally on artificial media, and a classification which places a great emphasis on the yeast-like appearance of the fungus in lesions is not exactly justifiable. Brumpt ('27) places the organism in the genus *Mycoderma*, calling it *M. dermatitis*. This terminology, however, is synonymous with *Oidium*, and in that case is likewise useless.

For a great number of years, no great work was done to establish definitely the position of Gilchrist's organism, and the name *Blastomyces* as created by him still held sway. The term presents a lot of difficulties. In the first place, the Blastomycetes, according to Buschke, are that group which develops through budding, provided a mycelium is formed on agar, while to the group of Blastomycetes, as Naegeli names budding, would belong the genera *Endomyces*, *Saccharomyces*, *Cryptococcus*, *Monilia*, and *Oidium*. Now the question arises as to what the actual meaning of the word blastomycete is. According to Vuillemin ('01), it does not designate a natural group, a botanical family based on genealogical affinities. There is in existence a genus *Blastomyces*, but these organisms are not budding fungi in the sense of Buschke. They are filamentous fungi whose spore-bearing elements, whether terminal, lateral, or intercalary, can be isolated by disarticulation, following Costantin and Rolland (quoted by Vuillemin). Frank (quoted by Vuillemin) established the Blastomycetes as an order to include such fungi as the beer yeasts whose elements are isolated by budding and not by disarticulation. In this respect, by virtue of the law of priority, it would seem that the name Blastomycetes, as designated by Frank, should remain. However,

if by general agreement the name of a genus could replace that of an order, then, according to the rules of nomenclature, the genus of Costantin and Rolland is legal, and the name as designated here is not legitimate by reason of the lack of distinct characters which have no generic value.

Castellani recently proposed a new classification of yeast-like or budding fungi based on the presence or absence of ascospores, which includes families of both the Ascomycetes and Fungi Imperfecti.

1. Saccharomycetaceae: budding cells, asci, and ascospores, but no mycelium in culture.

2. Endomycetaceae: budding cells, asci, and ascospores, with mycelium in culture.

3. Cryptococcaceae: budding cells (blastospores), no asci and no mycelium in culture.

4. Oosporaceae: budding cells, no asci, but mycelium in culture.

In addition to this family classification, he created a new genus which he calls *Blastomycoides*, to which he assigns three species, and places it in the family Oosporaceae: 1. *Blastomycoides dermatitidis*, synonym *Blastomyces dermatitidis* Gilchrist and Stokes; 2. *Blastomycoides immitis*, synonym *Coccidioides immitis* Rixford and Gilchrist; 3. *Blastomycoides tulanensis* Castellani. He defines the genus *Blastomycoides* as: "Oosporaceae appearing in the lesions as large roundish cells from eight to twenty microns in diameter, or larger, with the protoplasm containing a number of well-marked granules or spherules, and with a membrane showing a well-defined double contour; in dextrose agar cultures a large amount of mycelium is present." He bases further differentiation of the three species on their cultural differences when grown on mannitol, lactose, glucose, and galactose agar.

The second species that he names, *Blastomycoides immitis*, has already been discussed and classified by the author in a previous paper (M. Moore, '32). The author has made no pretext of studying the third species, so that nothing can be said about that. The first species, however, *Blastomycoides dermatitidis*, is altogether misplaced, simply because there are asci present in the mycelium in culture. This of course would refer the genus to the family Endomycetaceae, in which group the writer definitely establishes the organism.

Observations on the growth, development, reproduction, and further evolution of the fungus show that there are budding cells in the lesions, mycelium formed on agar with an intermediate stage showing the change from the yeast-like to the filamentous form. In accordance with this, Mellon ('24, '26, '26a) has recorded the fact that asci do occur particularly "in the so-called secondary colonies of the cultures which also contained 'dauernzellen' and pigmented oidia." The author wishes to affirm Mellon's findings as to the presence of asci, but suggests that these structures are present in the third stage, whereas the second step would consist of the intermediary forms which have an appearance very much like greatly enlarged oidia. Furthermore, it would seem that Mellon's description was indefinite, inasmuch as he refers to an ascus as an ascospore, and oil droplets are suggested by him as being chromatin indicators and forerunners of the future spores. Such factors as these are very important in the taxonomy of this type of fungi and should not be dealt with so promiscuously. Furthermore, Mellon has not paid much attention to the fact that no matter how old the lesion may be the blastomycosis organism found there does not change from its yeast-like, budding growth until it has been transferred to artificial media, where the change is an adaptation to the mode of life it must lead; in other words, the change from active parasitism to one of saprophytism. It is to be understood, however, that a change such as suggested here will not necessarily reduce its viability, at least for the time being.

A study of the evolution of the organism has repeatedly shown, in several hanging-drop cultures, that reproduction is heterogamous, as given in the description, with the final formation in the series of a large eight-spored ascus. Mellon in his papers consistently shows a four-spored ascus. It would seem, therefore, that he either has an organism unlike the one here described for the blastomycosis parasite, or else he has taken for granted as spores the four oil droplets which may and often have been found to occur on a mature eight-spored ascus, as was evidenced by the author on another ascomycete, *Endomyces capsulatus* var. *isabellinus* Moore, which was described in a case in another paper (McBride and Thompson, '33) and also in *Endomyces*

capsulatus Rewbridge, Dodge and Ayers ('29). Furthermore, it is quite possible that Mellon has observed the ascus just previous to the division of the nuclei, in the formation of the eight-spored ascus. This latter statement is only a conjecture on the part of the writer, but in any case the cultural descriptions do not agree with those given by the early investigators and with which the organism here described does agree.

In view of such criteria, it would seem that the organism formerly described as *Blastomyces dermatitidis* Gilchrist 1894, is not strictly a member of that genus, the name of which, on account of its etymological derivation, is essentially a misnomer. Because of its morphological characteristics, *Blastomyces dermatitidis* does not present those affinities entirely but simply as one phase of its life cycle. However, particularly because of its ascomycetous attributes, it should belong to the class Ascomycetes, order Endomycetales, family Endomycetaceae, and because of its similarity in morphology and reproduction (perfect stage) to that of *Endomyces capsulatus* and its variety, it should belong to the genus *Endomyces*. If taxonomic position in this family and genus be dependent on the number of spores in the ascus, it would seem, according to Whitman ('13), that this organism should belong in the genus *Oleina*. However, the genus *Endomyces* contains a number of pathogenic species with eight-spored asci, whereas *Oleina* has no pathogenic species, and until a classification better than the one now in existence be established, *dermatitidis* should be placed with *Endomyces*.

From the above statement it would appear that the organism should now be known as:

Endomyces dermatitidis (Gilchrist 1894), M. Moore, n. comb.

Mycelium in lesions of budding yeast-like cells 7–12 μ in diameter and sometimes as much as 20 μ in length, occurring singly, in groups of two's, three's, or four's. Growth on agar of isodiametric cells 2–2½ μ in diameter on acid media and 3–4 μ in diameter on slightly alkaline media. Hyphae septate, with conidia pyriform or round, pedunculate or sessile, 5 μ in diameter. Racquet mycelium present, 5–6 μ in diameter at swollen portion and 3–3½ μ in diameter at narrow portion. Chlamydospores terminal or lateral or intercalary, 5½–7½ x 12–15 μ, or sometimes

round, 7 μ in diameter. Copulation heterogamous, asci spherical, 8–13 μ in diameter, with 8 spherical to ovoid, smooth, hyaline to light chamois-colored spores 2–3 μ in diameter, at maturity. Colony white in color, becoming cinnamon to brown with age.

Summary

1. The history of blastomycosis is given, with a review of the early work on yeast-like, fungous pathogenicity, and a report of the first case published.

2. The etiology and clinical manifestations represent a number of conditions due to several yeast or yeast-like organisms: *Saccharomyces*, *Oidium*, *Monilia*, *Endomyces*, *Cryptococcus*, and *Coccidioides*, which have been placed in one category to constitute the agents responsible for the syndrome-complex, blastomycosis.

3. The disease is shown to simulate several conditions, in which cases the diagnosis must be arrived at through the isolation of the organism and the application of Koch's postulates.

4. Immunological reactions and therapeutic measures are as yet indefinite as to specific results, although beneficial results have been reported by the use of iodides.

5. A case of blastomycosis of the arm and hand is reported.

6. There is a description of the organism, culturally and morphologically, showing its relationship to the class Ascomycetes.

7. The fungus is definitely established as *Endomyces dermatitidis* of the family Endomycetaceae.

Acknowledgments

The author wishes to express his sincere gratitude to the following: Dr. Carroll W. Dodge, Professor of Botany in the Henry Shaw School of Botany of Washington University, for his interest, criticisms, and helpful suggestions; Dr. George T. Moore, Director of the Missouri Botanical Garden, for the courtesies extended; Dr. Martin F. Engman, Dermatologist to the Washington University Hospitals, for the use of the data with respect to the case reported; and Miss Nell C. Horner, librarian of the Missouri Botanical Garden, for her assistance.

Bibliography

Agostini, A. ('31). On Blastomycoides lanuginosus Castellani. Jour. Trop. Med. & Hyg. **34**: 287–288. 1931.

Basgal, W. ('31). Contribuição ao estudo das blastomycoses pulmonares. Doctorate thesis in medicine. Rio de Janeiro, 1931.

Bassoe, P. ('06). Report of a case of disseminated blastomycosis of the lungs, lumbar vertebrae and subcutaneous tissues. Chicago Path. Soc., Trans. **6**: 380. 1906.

Benedek, T. ('28). Bemerkungen zum Zuchtungsverfahren des Schizosaccharomyces hominis Benedek, 1927. I Mitteilung. Die Primarkultur. Derm. Wochenschr. **87**: 1203–1214. 1928.

————, and R. Fruhwald ('28). Clinical picture, mycology and serum diagnosis of schizosaccharomycosis; 2 cases. *Ibid.*, 1566–1577. 1928.

Blanchard, R., E. Swartz, et J. Binot ('03). Sur une blastomycose intrapéritonéale. Arch. de Parasitol. **7**: 489–507. 1903.

Bigot, A., et H. Velu ('25). Isolement rapide de Cryptococcus mirandei en culture pure. Soc. Path. Exot., Bull. **18**: 127–129. 1925.

————, ————, ('25a). Étude biologique de Cryptococcus mirandei agent de la blastomycose des voies lacrymales de l'âne. *Ibid.*, 231–235. 1925.

('25b). Contribution à l'étude des blastomycoses animales. Rev. Path. Comp. et Hyg. Gén. **25**: 280, 281, 283. 1925.

Borzone, R. A. ('29). Un caso de blastomicosis en Santa Fé y ensaya de revisión de las blastomicosis americanas. Soc. Scient. Santa Fé, An. **1**: 58–62. 1929.

Bowen, J., and S. B. Wolbach ('06). A case of blastomycosis; the results of culture and animal experiments. Jour. Med. Res. **10**: 167–177. 1906.

Brown, P. K., and W. T. Cummins ('15). I. A differential study of coccidioidal granuloma and blastomycosis. II. Report of two additional cases of coccidioidal disease. Arch. Int. Med. **15**: 608–627. 1915.

Brumpt, E. ('27). Précis de parasitologie. pp. 1213, 1383. Masson et Cie. Paris, 1927.

Burkhead, C. E. ('22). Oidiomycosis, including one case of coccidioidal granuloma and one of cutaneous blastomycosis. Kan. Med. Soc., Jour. **22**: 101. 1922.

Buschke, A. ('98). Ueber Hautblastomykose. Deutsch. Derm. Gesell., Verhandl. **6**: 181–222. 1898.

————, und A. Joseph ('28). Blastomykose (Ascomykose). In Jadassohn, Handbuch der Haut- und Geschlechtskrankheiten **11**: 825–925. 1928.

Busse, O. ('94). Ueber parasitaire Zelleinschlusse und ihre Zuchtung. Centralbl. f. Bakt. Orig. **16**: 175–180. 1894.

————, ('95). Ueber Saccharomycosis hominis. Virch. Arch. **140**: 23–46. 1895.

Castellani, A. ('25). Observations on some diseases of Central America. (Blastomycosis in man in Central America.) Jour. Trop. Med. & Hyg. **28**: 1–14. 1925.

————, ('25a). Notes on three new yeast-like organisms and a new bacillus, with remarks on the clinical conditions from which they have been isolated; furunculosis blastomycetica, macroglossia blastomycetica, stomatitis cryptococcobacillaris. *Ibid.*, 217–223. 1925.

————, ('28). Fungi and fungous diseases. Am. Med. Assoc. Chicago, 1928.

('28a). Notes on blastomycosis; its etiology and clinical varieties. Roy. Soc. Med., Sect. Trop. Dis. & Parasitol., Proc. **21**: 447–462. 1928.

Castellani, A., ('28b). Blastomycosis and some other conditions due to yeast-like fungi (budding fungi). Am. Jour. Trop. Med. **8**: 379–422. 1928.

———, ('29). Mannitol agar in the differentiation of the fungi of type Blastomyces. Soc. Exp. Biol. & Med., Proc. **26**: 544. 1929.

Chatenewer ('28). Material zur experimentellen Blastomykose des Kaninchens. Derm. Wochenschr. **87**: 1649. 1928.

Chiari, H. ('30). Zur Pathologie und Histologie der generalisierten Torulose (Blastomykose). Arch. f. Derm. u. Syph. **162**: 422–441. 1930.

Chyurlia, N. ('26). Notes on a case of bronchomycosis. Jour. Trop. Med. & Hyg. **29**: 145–146. 1926.

Cleary, J. H. ('04). A case of generalized blastomycosis. Chicago Path. Soc., Trans. **6**: 105–113. 1904.

Cleland, J. B. ('27). A case of systemic blastomycosis with the formation of a myxomatous-looking tumor-like mass. Med. Jour. Australia **14**: 337–340. 1927.

Cole, W. H. ('24). Systemic blastomycosis. Ann. Surg. **80**: 124–134. 1924.

Copelli, M. ('13). A case of blastomycosis. Jour. Cut. Dis. **31**: 51–52. 1913.

Corselli, G., und B. Frisco ('95). Pathogene Blastomyceten beim Menschen. Beiträge zur Aetiologie der bosartigen Geschwülste. Centralbl. f. Bakt. **18**: 368–373. 1895.

Coupal, J. F. ('24). Diagnosis and treatment of certain disease entities. Report of six cases of blastomycosis. Internat. Clin. **4**: 1–14. 1924.

Curtis, F. ('96). Contribution à l'étude de la saccharomycose humaine. Inst. Past., Ann. **10**: 449–468. 1896.

Davis, B. F. ('11). The immunological reactions of oidiomycosis (blastomycosis) in the guinea-pig. Jour. Inf. Dis. **8**: 190. 1911.

———, ('22). Blastomycosis: Clinical pathology and therapeusis. Minn. Med. **5**: 311–315. 1922.

Davis, C. N. ('06). A case of blastomycetic dermatitis. Jour. Cut. & Vener. Dis. **24**: 90. 1906.

Dennis, F. L. ('18). Blastomycosis of the upper respiratory tract with a report of a case primary in the larynx. Ann. Otol., Rhin. & Laryng. **27**: 571. 1918.

Desjardins, A. U. ('25). Roentgenotherapy and diathermy in blastomycosis. Am. Jour. Roentgenol. **14**: 14–16. 1925.

Dowling, G. B., and R. R. Elworthy ('25). A case of blastomycetic dermatitis (Gilchrist). Roy. Soc. Med., Proc. **19**: 4–10. 1925.

Downing, E. D. ('18). A case of blastomycosis with laryngeal involvement. Am. Med. Assoc., Jour. **70**: 85–86. 1918.

Eisendrath, D. N., and O. S. Ormsby ('05). A case of systemic blastomycosis in the sputum. *Ibid.* **45**: 1045. 1905.

Engelhardt, W. ('24). Ein Beitrag zur Aetiologie oberflachlicher Hautblastomykosen und Hautsoormykosen. Arch. f. Derm. u. Syphil. **146**: 313–322. 1924.

Evans, N. ('03). A clinical report of a case of blastomycosis of the skin from accidental inoculation. Am. Med. Assoc., Jour. **40**: 1772–1775. 1903.

———, ('09). Coccidioidal granuloma and blastomycosis in the central nervous system. Jour. Inf. Dis. **6**: 523–526. 1909.

Fabry, J. ('25). Superficial erosive blastomycosis. Derm. Wochenschr. **81**: 1071–1075. 1925.

———, ('27). Über akneformige blastomycosis cutis. *Ibid.* **84**: 824–827. 1927.

Ferguson, A. S. ('28). Blastomycosis of eye and face secondary to lung infection. Brit. Med. Jour. **1**: 442–443. 1928.

da Fonseca, O. ('22). Sobre as agentes das blastomycoses europeas. Cyclosexuadoe possiçao systematico do levedo de Hudelo. Brasil-Med. **36**: 101–102. 1922.

———, ('28). Ensaya de revisión de las blastomicosis sudamericanos. Inst. Clin. Quirurg., Bol. **4**: 469–502. 1928.

———, et A. E. de Arêa Leão ('28). Dermatite blastomycosique. Soc. Biol., Compt. Rend. **98**: 622–623. 1928.

Fontaine, B. W., M. Haase, and R. H. Mitchell ('09). Systemic blastomycosis. Arch. Int Med. **4**: 101–117. 1909.

Forgues, J. B. C. ('13). Contribution à l'étude des exoascées pathogènes. Thèse de Bordeaux, 100 pp. 1913.

Foulerton, A. ('00). On the pathogenic action of blastomycetes. Jour. Path. & Bact. **6**: 37–63. 1900.

Freeman, W., and F. D. Weidman ('23). Cystic blastomycosis of cerebral gray matter caused by Torula histolytica Stoddard and Cutler. Arch. Neurol. & Psychiat. **9**: 589–603. 1923.

Froilano de Mello, et A. Rodrigues ('29). Sur un cas de blastomycose à placards multiples végétants verruqueux ou pustulo-ulcérés. Soc. Path. Exot., Bull. **22**: 142–147. 1929.

Garr, C. C. ('25). Systemic blastomycosis. Surg. Gyn. & Obs. **41**: 490–492. 1925.

Gáspár, I. ('29). Blastomycotic meningo-encephalitis. Arch. Neurol. & Psychiat. **22**: 475–486. 1929.

Gilchrist, T. C. ('96). A case of blastomycetic dermatitis in man. Johns Hopkins Hosp., Repts. **1**: 269–283. 1896.

———, ('02). Blastomycetic dermatitis in the negro. Brit. Med. Jour. **2**: 1321–1328. 1902.

and W. R. Stokes ('96). The presence of an Oidium in the tissues of a case of pseudo-lupus vulgaris. Johns Hopkins Hosp., Bull. **7**: 129–133. 1896.

, ('98). A case of pseudo-lupus-vulgaris caused by a blastomyces. Jour. Exp. Med. N. Y. **3**: 53–78. 1898.

Graves, M. L. ('22). Systemic blastomycosis. Am. Jour. Trop. Med. **2**: 123–132. 1922.

Greenfield, J. G. ('24). Blastomycosis of nervous system. Med. Sci. **10**: 267–273. 1924.

Grschebin, S. ('27). Ein Fall von tiefer primärer Blastomykosis der Haut (Busse-Buschke). Derm. Wochenschr. **85**: 1049–1055. 1927.

———, ('28). Deep primary blastomycosis of the skin. Urol. & Cutan. Rev. **32**: 453–457. 1928.

und L. N. Maschkilleisson ('26). Beitrage zur Lehre von der pathologischen Anatomie der Gilchristchen Hautblastomykose. Derm. Wochenschr. **82**: 811–818. 1926.

Haase, M., E. R. Hall, and C. H. Marshall ('22). Local blastomycosis, report of a case. Am. Med. Assoc., Jour. **79**: 820–822. 1922.

Hagiwara, S. ('22). Über Blastomycosis cutis. Jap. Zeitschr. Derm. Urol. **22**: 941–980. 1922.

Hamburger, W. W. ('07). A comparative study of four strains of organism isolated from four cases of generalized blastomycosis. Jour. Inf. Dis. **4**: 201–209. 1907.

Hamilton, C. M. ('26). Blastomycosis. South. Med. Jour. **19**: 431–435. 1926.

Harter, A. ('09). De la blastomycose humaine. Thèse Fac. Méd. Nancy 8: 222. 1909.
Hashimoto, T. ('22). Über Blastomycosis cutis. Jap. Zeitschr. Derm. Urol. **22**: 1–34. 1922.
Hedge, H. M. ('28). The use of carbon dioxide snow in treating blastomycosis. Am. Med. Assoc., Jour. **90**: 1367–1369. 1928.
Hektoen, L. ('99). The organism in a case of blastomycetic dermatitis. Jour. Exp. Med. **4**: 261–278. 1899.
————, ('07). Systemic blastomycosis and coccidioidal granuloma. Am. Med. Assoc., Jour. **49**: 1071–1077. 1907.
Herrick, J. B. ('07). Generalized blastomycosis. *Ibid.* 328. 1907.
Hessler, R. ('99). Blastomycetic dermatitis. *Ibid.* **32**: 760. 1899.
Hicks, J. A. B., and F. R. Chopping ('24). Case of perionychia due to a blastomyces. Lancet **206**[1]: 128. 1924.
Hill, H. P., and E. C. Dickson ('14). Report of a case of systemic blastomycosis. Calif. State Jour. Med. **12**: 120. 1914.
Howes, W. B., and P. F. Morse ('21). Report of two cases of blastomycosis. Boston Med. & Surg. Jour. **185**: 315–317. 1921.
Hudelo, Rubens-Duval, et Laederich ('06). Étude d'un cas de blastomycose à foyers multiples. Soc. Méd. Hôp. Paris, Bull. et Mém. **23**: 723–734. 1906.
Hufschmitt, G., A. Sartory, R. Sartory, et J. Meyer ('31). Un cas de blastomycose cutanée à foyers multiples. Ann. Dermatol. **7**: 850–876. 1931.
Hurley, T. D. ('16). Heart lesion in blastomycosis. Jour. Med. Res. **33**: 499–502. 1916.
Hyde, J. N., L. Hektoen, and A. D. Bevan ('99). A contribution to the study of blastomycetic dermatitis. Brit. Jour. Derm. **11**: 261–276. 1899.
Irons, E. E., and E. A. Graham ('06). Report of a case with miliary and ulcerative blastomycosis of the lungs. Miliary blastomycosis of the spleen and multiple superficial and deep abscesses. Jour. Inf. Dis. **3**: 666–682. 1906.
Jackson, C. ('26). Blastomycosis of the larynx. Arch. Otolaryng. **3**: 99–107. 1926.
Jackson, R. H. ('26). Surgical treatment of certain massive blastomycetic skin lesions. Am. Jour. Surg. **1**: 185–187. 1926.
Jacobson, H. P., J. F. Schamberg, and H. Morrow ('32). Fungous diseases. A clinico-mycological text. pp. 149–181. Charles C. Thomas Co., Springfield, Illinois. 1932.
Jeaume, G., et M. Dekester ('25). Isolement de l'agent pathogène de la blastomycose des voies lacrymales. Soc. Path. Exot., Bull. **18**: 124–127. 1925.
Jona, G. ('97). Die Schutzmittel des Organismus gegen Blastomyceten. Centralbl. f. Bakt. **21**: 147–150. 1897.
LeCount, E. R., and J. Myers ('05). Systemic blastomycosis. Final report of the case described by Eisendrath and Ormsby in 1900. Jour. Inf. Dis. **4**: 187–200. 1905.
Legendre, J. ('27). À propos de la dermatite blastomycosique chéloidienne. Soc. Path. Exot., Bull. **20**: 323. 1927.
Lewis, D. ('17). Blastomycosis and sporotrichosis. Surg. Clinics, Chicago **1**: 1125. 1917.
MacLeod, J. M. H. ('30). Some skin affections due to yeast-like fungi. Brit. Med. Jour. **1930**: 1119–1123. 1930.

Maffuci, A., und L. Sirleo ('98). Ueber die Blastomyceten als Infektionserreger bei bösartigen Tumoren. Zeitschr. f. Hyg. **27**: 1–30. 1898.

Maner, G. D., and R. W. Hammack ('30). Systemic blastomycosis. Calif. & West. Med. **32**: 87–90. 1930.

Massey, A. Y. ('16). Blastomycosis (?) in Central Africa. Jour. Trop. Med. & Hyg. **19**: 79. 1916.

Mazza, S., y F. Niño ('28). Notas sobre blastomicosis de las vias respiratorias. Reunión Soc. Argentina Patol. Reg. Norte en Santiago del Estero **4**: 545–548. 1928.

———, ———, H. Quintana, y V. Bernasconi ('30). Blastomicosis grave generalizada por Monilia n. sp. Reunión Soc. Argentina Patol. Reg. Norte en Salta **6**: 180–214. 1930.

y F. Canevari ('29). Ulceras blastomicosicas de la lengua. Reunión Soc. Argentina Patol. Reg. Norte **5**: 226–230. 1929.

———, F. L. Niño, y P. Nicolini ('29). Blastomicosis de la mucosa labiogeniana. *Ibid.* 231–239. 1929.

y A. Egües ('29). Perionixis blastomicética por Monilia (n. sp.). *Ibid.* 284–288. 1929.

———, L. Stábile de Nucci, y E. J. Canal Feijóo (Santiago del Estero) ('29). Blastomicosis cutánea de forma lenta por criptococa (n. sp.). *Ibid.* 293–308. 1929.

—, y B. Palamedi ('32). Caso mortal de blastomicosis cutáneo mucosa. Reunión Soc. Argentina Patol. Reg. Norte en Tucumán **7**: 424–467. 1932.

McKee, S. H. ('26). Blastomycosis of the cornea, with review of reported cases of blastomycosis of the eye. Internat. Clin. **3**: 50–57. 1926.

Meckel, M. ('27). Weitere Mitteilungen uber erosive Blastomykosen. Derm. Wochenschr. **84**: 817–824. 1927.

Medlar, E. M. ('27). Pulmonary blastomycosis; its similarity to tuberculosis. Am. Jour. Path. **3**: 305–314. 1927.

Mellon, R. R. ('24). Observations on an ascospore stage for the parasites of blastomycosis hominis. Exp. Biol. & Med., Proc. **22**: 69. 1924.

———, ('26). Studies in microbic heredity. VI. The infective and taxonomic significance of a newly described ascospore stage for the fungi of blastomycosis. Jour. Bact. **11**: 229–252. 1926.

('26a). Studies in microbic heredity. VII. Observations on the genetic origin of the several types of fungi found in the lesions of blastomycosis hominis. *Ibid.* 419–432. 1926.

Michelson, I. D. ('28). Blastomycosis; pathologic and bacteriologic study. Am. Med. Assoc., Jour. **91**: 1871–1876. 1928.

Miller, J. E. ('25). Yeast-cell formation in man. U. S. Navy Med. Bull. **23**: 229–235. 1925.

Miller, W. S. ('27). The reticulum of the lung: Its similarity in blastomycosis to that in tuberculosis. Am. Jour. Path. **3**: 315–320. 1927.

Montel, R., and R. Pons ('26). Dermatite blastomycosique chéloidienne. Soc. Path. Exot., Bull. **19**: 876–880. 1926.

Montgomery, F. H. ('03). A case of cutaneous blastomycosis followed by laryngeal and systemic tuberculosis. Death; autopsy. Jour. Cut. Dis. **21**: 19–22. 1903.

———, and O. S. Ormsby ('08). Systemic blastomycosis: Its etiologic, pathologic and clinical features as established by a critical survey and summary of twenty-

two cases, seven previously unpublished. The relation of blastomycosis to coccidioidal granuloma. Arch. Int. Med. **2:** 1–41. 1908.

Montpellier, J., et A. Catanei ('26). Blastomycose de l'avant-bras chez une femme indigène d'Alger. Soc. Path. Exot., Bull. **19:** 586–592. 1926.

Moore, J. T. ('20). Blastomycosis. Report of a case dying from abscess of brain. Surg., Gyn. & Obs. **31:** 590–594. 1920.

Moore, M. ('32). Coccidioidal granuloma: A classification of the causative agent, Coccidioides immitis. Mo. Bot. Gard., Ann. **19:** 397–428. 1932.

[————], MacBryde, C. M., and E. J. Thompson. ('33). Meningitis and dermatitis caused by a new variety of blastomycete (endomycete). Arch. of Derm. & Syphil. **27:** 49–69. 1933.

Morris, R. T. ('13). A case of systemic blastomycosis. Am. Med. Assoc., Jour. **61:** 2043–2044. 1913.

Nesczadimenko, A. ('99). Zur Pathogenese der Blastomyceten. Centralbl. f. Bakt. **25:** 55–58. 1899.

Neumayer, J. ('91). Untersuchungen · über die Wirkungen der verschiedenen Hefearten, welche bei der Bereitung weingustiger Getränke vorkommen auf den thierischen und menschlichen Organismus. Arch. f. Hyg. **12:** 1–60. 1891.

New, G. B. ('17). Blastomycosis of the tongue. Am. Med. Assoc., Jour. **68:** 186. 1917.

————, ('28). Blastomycosis of the larynx. Ann. Otol., Rhin. & Laryng. **37:** 240–250. 1928.

Nieberle, N. ('27). Blastomycosis of skin in pig. Virch. Arch. f. path. Anat. **263:** 16–24. 1927.

Niño, F. L. ('29). Ulceración blastomicética cutáneomucosa del labio inferior (Consideraciones acerca de su diagnóstica etiológico). Reunión Soc. Argentina Patol. Reg. Norte **5:** 213–225. 1929.

————, ('29a). Onixis y perionixis de origen blastomicósico (Estudio clinico y micológico). *Ibid.* 270–282. 1929.

————, ('30). Blastomicosis humano generalizada por Criptococo (n. sp.). Reunión Soc. Patol. Reg. Norte en Salta **6:** 117–167. 1930.

————, y J. Fernandez ('29). Nueva observacion de perionixis per Monilia periunguealis. Reunión Soc. Patol. Reg. Norte **5:** 282–283. 1929.

————, y M. Palant ('30). Nuevas observaciones de onixis y perionixis de origen blastomicosico. Reunión Soc. Argentina Patol. Reg. Norte en Salta **6:** 35–99. 1930.

Ormsby, O. S. ('21). Blastomycosis. A practical treatise on diseases of the skin. Lea & Febiger, Philadelphia & New York. 1921.

————, and H. M. Miller ('03). Report of a case of systemic blastomycosis with multiple cutaneous and subcutaneous lesions. Jour. Cut. Dis. **21:** 121–136. 1903.

Ota, M. ('24). Essai de classification des blastomycètes pathogènes. Ann. Parasitol. **2:** 34–61. 1924.

Otis, F. J., and N. Evans ('03). Morphology and biology of the parasite from a case of systemic blastomycosis. Am. Med. Assoc., Jour. **41:** 1075–1082. 1903.

Panja, G. ('25). A case of generalized blastomycosis. Ind. Med. Gaz. **60:** 475–476. 1925.

Parker, C. A. ('23). Actinomycosis and blastomycosis of the spine. Jour. Bone & Joint Surg. **5:** 759–777. 1923.

Parmenter, F. J., and B. T. Simpson ('19). A case of blastomycosis involving the prostate and seminal vesicles. Jour. Urol. **3**: 449. 1919.

Rabinowitsch, L. ('96). Untersuchungen über pathogene Hefearten. Zeitschr. f. Hyg. u. Infektionskrank. **21**: 11–24. 1896.

Raum, J. ('91). Zur Morphologie und Biologie der Sprosspilze. *Ibid.* **10**: 1–50. 1891.

Reed, P. A. ('26). Systemic blastomycosis. Neb. Med. Jour. **11**: 257–260. 1926.

Rewbridge, A. G., C. W. Dodge, and T. T. Ayers ('29). A case of meningitis due to Endomyces capsulatus (new species). Am. Jour. Path. **5**: 349–364. 1929.

Rhamy, B. W. ('26). Blastomycosis of the bladder. Am. Med. Assoc., Jour. **87**: 405–406. 1926.

Richter, W. ('28). Beiträge zur Hefepilzerkrankung. Derm. Wochenschr. **87**: 931–940. 1928.

Ricketts, H. T. ('01). Oidiomycosis (blastomycosis) of the skin and its fungi. Jour. Med. Res. **6**: 374–547. 1901.

————, ('01a). A new mould fungus as the cause of three cases of blastomycosis or oidiomycosis of the skin. Boston Soc. Med. Sci., Jour. **5**: 453–459. 1901.

Roncali, D. B. ('95). Die Blastomyceten in den Sarkomen. Centralbl. f. Bakt. **18**: 432–434. 1895.

Ryerson, E. W. ('08–'09). Blastomycosis: Report of two cases resembling bone tuberculosis. Am. Jour. Orthoped. Surg. **6**: 79–83. 1908–1909.

Sanderson, E. S., and D. C. Smith ('27). The effect of gentian-violet on the organism of blastomycosis infection. Arch. Derm. & Syph. **16**: 153–155. 1927.

Sanfelice, F. ('95). Ueber einen neuen pathogenen Blastomyceten, welcher innerhalb der Gewebe unter Bildung kalkartig aussehender Massen degeneriert. Centralbl. f. Bakt. **18**: 521–526. 1895.

————, ('96). Ueber die pathogene Wirkung der Blastomyceten. I. Abhandlung. Zeitschr. f. Hyg. **21**: 32–58. 1896.

————, ('96a). *Ibid.* II. Abhandlung. *Ibid.* 390–420. 1896.

Schlossman, C. R. ('29). Two cases of blastomycosis cutis. Acta Dermato-Venereol. **10**: 83–94. 1929.

Simoni, A. de ('97). Ueber das Vorkommen von Blastomyceten in der Hypertrophischen Tonsille. Centralbl. f. Bakt. **22**: 120–122. 1897.

Smith, D. C., H. C. Turner, and E. S. Sanderson ('28). Systemic blastomycosis with a report of a fatal case. Brit. Jour. Derm. **40**: 344–359. 1928.

Speroni, D., J. Llambias, S. E. Parodi, y. F. L. Niño ('29). Blastomicosis humano generalizado por criptococo (n. sp.). Estudio parasitológico, anátomopatológica, clinico y experimental. Reunión Soc. Argentina Patol. Reg. Norte **5**: 94–155. 1929.

Spring, D. ('29). Comparison of seven strains of organisms causing blastomycosis in man. Jour. Inf. Dis. **44**: 169–185. 1929.

Stearn, E. W., and A. E. Stearn ('29). Comparative inhibiting effect of gentian violet and mercurochrome on the growth of certain fungi. Jour. Lab. & Clin. Med. **14**: 1057–1060. 1929.

Stober, A. M. ('14). Systemic blastomycosis. Arch. Int. Med. **13**: 509–556. 1914.

Stovall, W. D., and H. P. Greeley ('28). Bronchomycosis. Report of eighteen cases of primary infection in the lung. Am. Med. Assoc., Jour. **91**: 1346–1351. 1928.

Sugden, F. ('23). Case of blastomycosis. Brit. Med. Jour. **2**: 63. 1923.

Sutejew, G., M. Utenkow, and A. Zeitlin ('29). Beitrag zur Ätiologie, Röntgendiagnose und Röntgentherapie der Blastomykose. Fortschr. Geb. Röntgenstr. **11**: 475–483. 1929.

T., F. E. ('28). Cutaneous moniliases. Trop. Med. & Hyg. Jour. **31**: 37–38. 1928.

Toepel, T. ('29). Systemic blastomycosis. Am. Med. Assoc., Jour. **93**: 32. 1929.

Tokishige, H. ('96). Ueber pathogene Blastomyceten. Centralbl. f. Bakt. **19**: 105–113. 1896.

Troisier, E., et P. Achalme ('93). Sur une angine parasitaire causée par une levure et cliniquement semblable au muguet. Arch. Méd. Expér. **5**: 29–37. 1893.

Urbach, E., und F. Zach ('30). Generalisierte Torulose (Europaeische Blastomykose). Eine klinisch-botanisch Studie. Arch. f. Derm. u. Syphil. **162**: 401–421. 1930.

Vuillemin, P. ('01). Les blastomycètes pathogènes. Rev. Gén. des Sci. **12**: 732–751. 1901.

————, ('10). Matériaux pour une classification rationelle des Fungi Imperfecti. Compt. Rend. Acad. Paris **150**: 882. 1910.

Wade, H. W. ('16). A variation of gemmation of Blastomyces dermatitidis in the tissue lesion. Jour. Inf. Dis. **18**: 618–629. 1916.

————, ('18). Portal of entry in experimental chronic pulmonary (systemic) blastomycosis. Philipp. Jour. Sci. **13**: 271. 1918.

————, and G. S. Bell ('16). A critical consideration of systemic blastomycosis. Arch. Int. Med. **18**: 103. 1916.

Walker, J. W., and F. H. Montgomery ('02). Further report of a previously reported case of blastomycosis of the skin: Systemic infection with blastomyces; death; autopsy. Am. Med. Assoc., Jour. **38**: 867–871. 1902.

Wanamaker, T. ('28). A case of blastomycosis of the cervical lymph gland. Am. Laryng., Rhin. & Otol. Soc., Trans. **34**: 450–452. 1928.

Weidman, F. D., and H. R. Douglas ('21). Blastomycetoid bodies in a sarcoma-like tumor of the leg. Arch. of Derm. & Syphil. **3**: 743–752. 1921.

Wernicke, R. ('92). Über einen Protozoenbefund bei Mycosis fungoides (?). Centralbl. f. Bakt. **12**: 859–861. 1892.

Whitman, R. C. ('13). A contribution to the botany of the organism of blastomycosis. Jour. Inf. Dis. **13**: 85–94. 1913.

Wilhelmj, C. M. ('25). The primary meningeal form of systemic blastomycosis. Am. Jour. Med. Sci. **169**: 712–721. 1925.

Wohl, M. G. ('23). Fungous diseases of man in the State of Nebraska; sporotrichosis; blastomycosis; actinomycosis. Am. Med. Assoc., Jour. **81**: 647–653. 1923.

Yakimoff, W. L., and W. J. Wassilewsky ('25). Au sujet de la blastomycose. Soc. Path. Exot., Bull. **18**: 130–132. 1925.

Zoon, J. J. ('30). Blastomycosis cutis durch Monilia floccoi mit positiver Blutkultur. Derm. Wochenschr. **58**: 356–367. 1930.

Explanation of Plate

PLATE 6

All drawings made with camera lucida at a magnification of × 800.

Figs. 1–9. Yeast-like cells.

Figs. 1, 6, 7. On Raulin's solution.

Figs. 2–5, 9. On Sabouraud's agar.

Fig. 8. On glycerine agar.

Figs. 10–12, 14–17. Yeast-like cells showing a change to mycelial formation.

Figs. 10, 12. On potato-dextrose agar.

Figs. 11, 14. On glycerine agar.

Figs. 15–17. On Sabouraud's agar.

Fig. 13. Germinating spores on Richards' solution agar.

Fig. 18. Heterogamous copulation of lateral cells on Sabouraud's agar.

Fig. 19. Heterogamous copulation of terminal cells on Richards' solution agar.

Fig. 20. Copulating branch on corn-meal agar.

Fig. 21. Maturing ascus on Richards' solution agar.

Fig. 22. Terminal hypnospore on Sabouraud's agar.

Fig. 23. Racquet mycelium on June-beetle agar.

Fig. 24. Mycelium showing conidia on Richards' solution agar.

Fig. 25. Mycelium showing round terminal chlamydospores and swollen hypha on nutrient agar.

Figs. 26, 28. Mycelium showing conidia, oidia-like cells, and resting cells on corn-meal agar.

Fig. 27. Chlamydospore on Czapek's agar.

Fig. 29. Mycelium showing conidia on potato-dextrose agar.

Fig. 30. Racquet formation on Czapek's agar.

Fig. 31. Terminal chlamydospore on lactose agar.

Fig. 32. Terminal hypnospore on Endo's agar.

Fig. 33. Maturing lateral ascus on Sabouraud's agar.

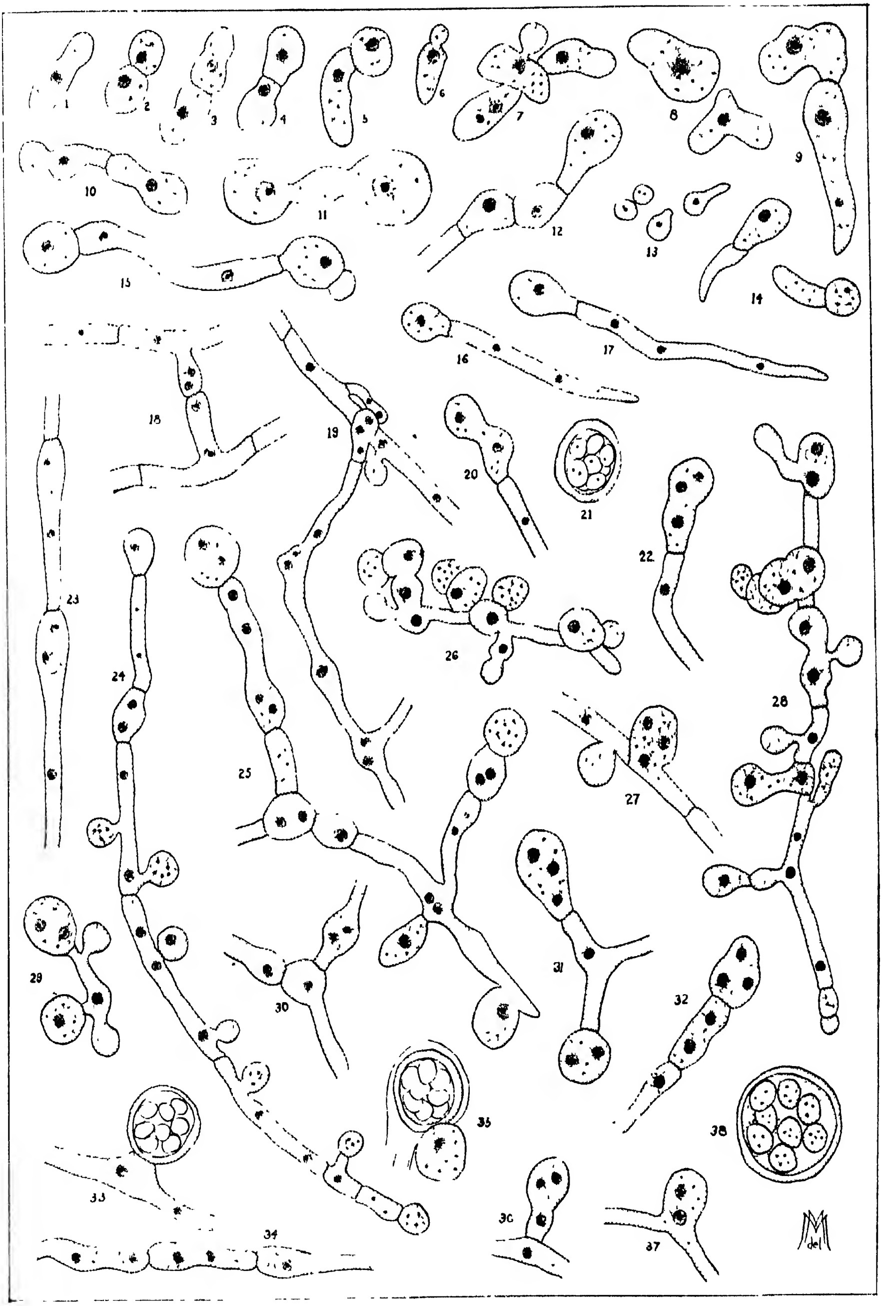
Fig. 34. Racquet mycelium on June-beetle dextrose agar.

Fig. 35. Ascus covered with a third sheath in proximity to a round resting cell, on potato-dextrose agar.

Fig. 36. Lateral chlamydospore on Czapek's agar.

Fig. 37. Resting cell on Sabouraud's agar.

Fig. 38. Mature ascus on potato-dextrose agar.



MOORE—BLASTOMYCOSIS

Explanation of Plate

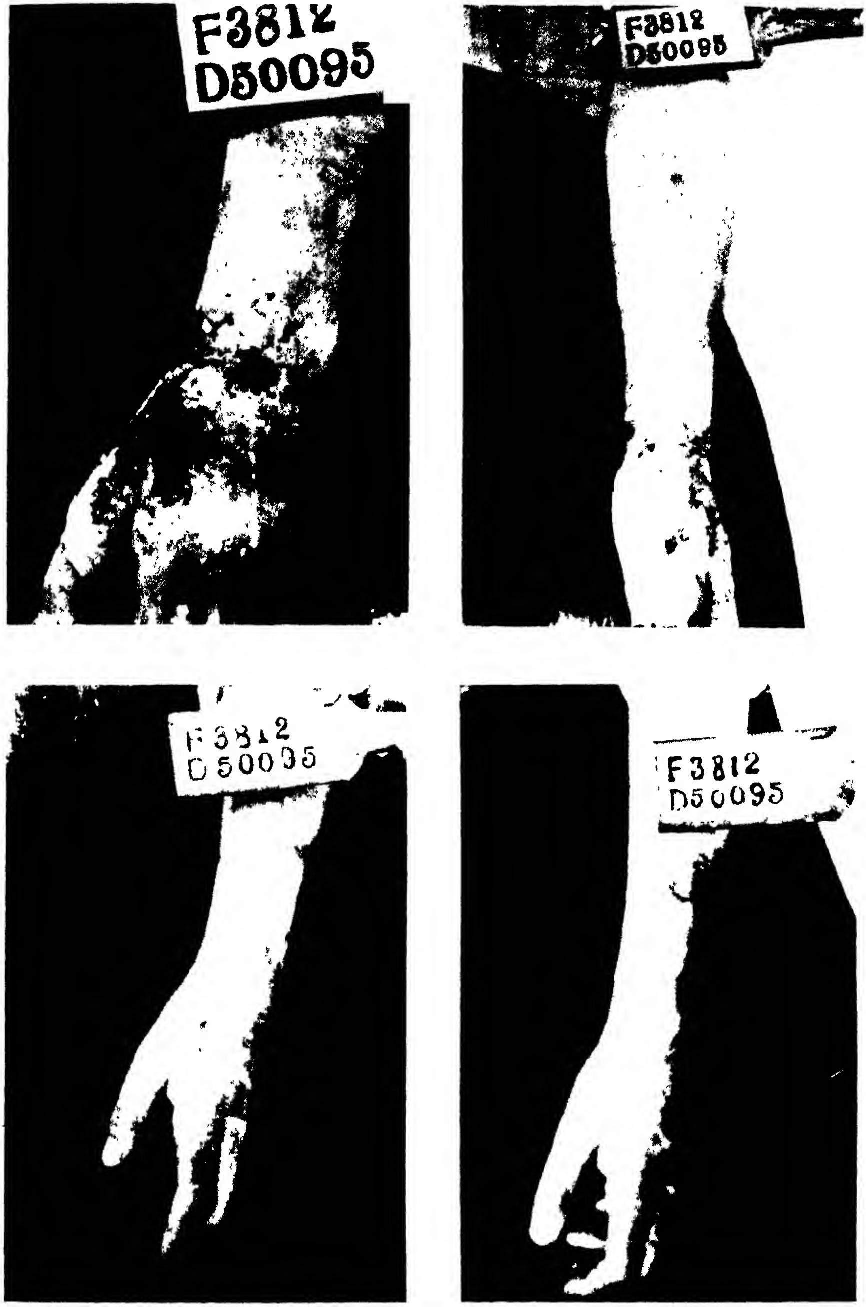
PLATE 7

Fig. 1. Photograph of hand of patient on day of entry, April 8, 1932, showing lesion involving portion of thumb.

Fig. 2. Photograph taken on April 8, 1932, showing abscess on flexor surface of left lower arm.

Fig. 3. Photograph showing marked improvement after treatment with sodium iodide intravenously.

Fig. 4. Photograph showing almost complete healing.



MOORE—BLASTOMYCOSIS

A MONOGRAPH OF THE AMERICAN SPECIES OF THE GENUS HALENIA[1]

CAROLINE K. ALLEN

Formerly Missouri Botanical Garden Special Fellow in Botany, Henry Shaw School of Botany of Washington University

Introduction

Frequent attempts to determine recent collections of *Halenia*, especially from Central and South America, have revealed the need for a comprehensive taxonomic treatment of the American species of the genus. Incidental determination of isolated species in herbaria, which furnish scanty material, has led to error and the duplication of species has resulted. Few of these fragmentary treatments are provided with adequate descriptions, and still fewer are accompanied by illustrations. The present paper is a monographic study of the American species of *Halenia*. The first portion is devoted to the North and Central American representatives of the genus and the second to those of South America.

The writer at this time wishes to express her appreciation to Dr. George T. Moore, Director of the Missouri Botanical Garden, where this work has been carried on, for the privilege of using the facilities afforded by the herbarium, library, and laboratory. It is with pleasure, indeed, that she also acknowledges the courteous assistance and helpful criticism offered by Dr. J. M. Greenman, under whose personal supervision the study was begun and completed.

For the loan of specimens for study the writer is especially indebted to the curators of the herbaria of the following institutions: Gray Herbarium of Harvard University, New York Botanical Garden, Philadelphia Academy of Natural Sciences, United States National Herbarium, Field Museum of Natural History, the Dudley Herbarium of Stanford University, Brooklyn Botanic Garden, Iowa Agricultural College, Natural History Mu-

[1] An investigation carried out at the Missouri Botanical Garden in the Graduate Laboratory of the Henry Shaw School of Botany of Washington University, and submitted as a thesis in partial fulfillment of the requirements for the degree of doctor of philosophy in the Henry Shaw School of Botany of Washington University.

Issued April 29, 1933.

seum of Vienna, Botanical Museum of Stockholm, the Delessert Herbarium at Geneva, Royal Botanic Gardens, Kew, and the British Museum of Natural History.

Particularly does the writer wish to express her gratitude to Mr. R. I. Cratty, of the Iowa State College, for the loan of specimens from the Parry Herbarium deposited there; to the curator of the Herbarium of the Botanical Garden of Madrid, for supplying a photograph of the type of *Swertia cucullata;* and to the curator of the Herbarium of the Jardin des Plantes, Paris, for photographs of the types of Humboldt, Bonpland and Kunth.

In connection with visits to various herbaria, the author desires to acknowledge the courtesy and kindly assistance of Dr. Ernst Gilg and Dr. Robert Pilger, of the Botanical Garden at Berlin-Dahlem; Dr. Walter Robyns of the Botanical Garden, Brussels; and Mr. Spencer Savage, in charge of the Linnaean Herbarium, of the Linnaean Society of London. Thanks are due also to Dr. George E. Nichols, Director of the Marsh Botanical Garden, Yale University, for his kindness in procuring seeds of *Halenia;* to Miss Nell C. Horner, Librarian of the Missouri Botanical Garden, and Dr. John H. Barnhart, of the New York Botanical Garden, for assistance in bibliography; to Dr. Roland V. La Garde, of the Missouri Botanical Garden, for preparation of photographs; and to the George F. Cram Company, for permission to use the copyright outline maps of North and South America.

History of the Genus

Linnaeus in the 'Amoenitates Academicae,'[1] which appeared in 1751, published short descriptions of two genera of the Gentianaceae, namely, *Swertia*, consisting of five species, and *Gentiana*, of twenty-three. Under *Swertia* Linnaeus listed the spurred gentian with the following description.

"4. Swertia corollis quadrifidis quadricornibus.
Amoen. acad. 2. p. 344.
Habitat in Sibiria, Gmelin; Canada, Kalm."

This was apparently the only species of spurred gentian he had

[1] Linnaeus, Amoen. Acad. 2: 344. 1751.

ever seen, and, it being closely related to the *Swertia* he knew, he placed it in that group, giving it the specific name *corniculata* or "horn-tipped," as distinct from the others.

Gmelin, in his 'Flora Sibirica,'[2] published in 1769, referred to this as being synonymous with his genus *Tetragonanthus*, which he had described or mentioned in a previous book or manuscript, and which he evidently based upon specimens collected by G. H. Stellar. This work contains a brief description, but a good illustration of *Swertia*.

On account of the presence of spurs on the corolla, Börckhausen,[3] in 1796, segregated *Swertia corniculata* from the Linnaean genus *Swertia* and called it *Halenia* after Jonas Halen. Although the latter had included a short description of it in a previously published dissertation on Kamtchatka plants, Börckhausen must be considered the author of the genus. He cited as a synonym *Swertia corniculata* Linnaeus, but changed the binomial name to *Halenia sibirica*.

The name *Swertia*, however, persisted for some time in literature, the generic descriptions becoming more elaborate and detailed with each publication. Ruiz and Pavon described and illustrated *Swertia umbellata* from Peru[4] in 1802. Michaux included the genus in his 'Flora Boreali-Americana'[5] appearing the following year, and Humboldt, Bonpland and Kunth,[6] described six new species from Mexico and South America in 1818. A few species, together with a new variety, were published in 'Linnaea' by Schlectendal and Chamisso[7] in 1830. But it was not until Grisebach began his extensive study of the Gentianaceae that any attempt was made to bring together the species of the world. As a result, when his 'Observationes'[8] appeared in 1836, followed in 1839 by the 'Genera et Species Gentianearum,'[9] many of the existing names fell to synonymy.

Grisebach divided *Halenia* into two main divisions: the first,

[2] Gmelin, Fl. Sib. 4: 114. 1769.
[3] Börckhausen in Roemer, Arkiv für Botanik 1^1: 25. 1796.
[4] Ruiz & Pavon, Fl. Peruv. 3: 21. *pl. 242.* 1802.
[5] Michaux, Fl. Bor.-Am. 1: 97. 1803.
[6] Humboldt, Bonpland & Kunth, Nov. Gen. & Sp. Pl. 3: 174. 1818.
[7] Schlectendal & Chamisso in Linnaea 5: 122. 1830.
[8] Grisebach, Obs. Gent. 36. 1836.
[9] Grisebach, Gen. & Sp. Gent. 322–328. 1839.

with spurs ascending and spreading; the second, with spurs pendulous to incurved. He devoted careful attention to the descriptions, synonymy, affinities, differentiating characters, and habitat of each species mentioned. The collector and type were given in each case. He also separated from the *Swertia* of Humboldt, Bonpland and Kunth two species, *brevicornis* and *parviflora*, and founded on them a new genus *Exadenus* distinguished by the presence of pits at the base of the corolla, instead of spurs, and by central placentation. This abolished the *Swertia* of Humboldt, Bonpland, and Kunth, which was based on *Swertia corniculata* Linnaeus, and left the non-spurred *Swertia* originally described by Linnaeus a genus entirely distinct from our present *Halenia*.

Hooker's 'Flora,'[10] published in 1840, contained good illustrations of *Halenia deflexa* with the varieties *Brentoniana* and *heterantha*.

Nearly a decade elapsed before any significant study was done on the genus as a whole. Bentham,[11] in 1839–1840, in describing Hartweg's plants from Mexico added two new species, *multiflora* and *decumbens*. Martens and Galeotti in 1844 in their "Enumeration of Mexican plants collected by Galeotti"[12] described, along with other new *Halenia* species, two new species of *Exadenus*. Walpers' 'Repertorium'[13] contains reference to *Exadenus*, but Weddell in 1859[14] merged the two genera. He considered the group as a whole to consist of two main subdivisions, the first being that group with spurs, and the second the spurless species. The former he subdivided into section 1—ovary unilocular; section 2—ovary bilocular, and the corolla having small spurs. Here he placed the two original species of *Exadenus* Grisebach which were based on the species of *Swertia* Humboldt, Bonpland & Kunth, namely, *parviflora* and *brevicornis*, but neglected to transfer the species described by Martens and Galeotti. The second subdivision, without spurs, he also divided into two sections, on the presence of a uni- or bilocular ovary.

[10] Hooker, Fl. Bor.-Am. 2: 67. *pl. 155–6.* 1840.
[11] Bentham, Pl. Hartw. 24. 1839; 67. 1840.
[12] Martens & Galeotti in Bull. Acad. Brux. 11[1]: 370. 1844.
[13] Walpers, Rep. Bot. Syst. 6: 508. 1846–47.
[14] Weddell, Chlor. And. 2: 74. 1859.

His argument for combining the two genera was based on the fact that the two characters, the bilocular ovary and the short spurs do not always coincide. In this work, he described five new South American species based on collections of Triana, Funck & Schlim, Goudot, Purdie, etc.

At the time of the publication of Bentham and Hooker's 'Genera Plantarum,'[15] 1876, there were about twenty-five recognized species of *Halenia* from the whole world.

Hemsley, in 'Biologia Centrali-Americana,'[16] which appeared in 1882, referred the *Exadenus* Martens and Galeotti to *Halenia*. Gilg in Engler and Prantl's 'Natürlichen Pflanzenfamilien'[17] recognized the validity of the generic name *Halenia* and included a careful description and good illustrations.

Sessé & Mociño's 'Flora'[18] contains a description of *Swertia cucullata* which has escaped the notice of succeeding monographers, and has not been transferred to *Halenia*. A photograph of the type specimen kindly furnished by Dr. E. Balguerias, Curator of the Botanical Garden at Madrid, reveals the fact that it is without question *Halenia brevicornis* Griseb., though it is rather difficult to determine whether or not it is the species proper or one of its many forms.

From this time until the monographic treatment of South American species was published by Gilg[19] in 1916, several species and varieties of Mexican and Central American *Halenia* were published. *Halenia Rothrockii* Gray,[20] now *Halenia recurva*, in 1876 was based on plants collected in Arizona by Dr. J. T. Rothrock. G. Don, in 1838, in the 'General History of the Dichlamydeous Plants'[21] included a description of the existing species of *Halenia*, making several new combinations from the species of Humboldt, Bonpland and Kunth.[22] Some of his species were taken from the manuscript of D. Don, thus appearing in

[15] Bentham & Hooker, Gen. Pl. 2: 817. 1876.
[16] Hemsley, Biol. Cent.-Am. Bot. 2: 351. 1882.
[17] Gilg in Engler & Prantl, Nat. Pflanzenfam. 4[2]: 89. 1895.
[18] Sessé & Mociño, Flora Mexicana, 73. 1894.
[19] Gilg in Engl. Bot. Jahrb. 54: Beibl. 118, pp. 93–122. 1916.
[20] Gray in Proc. Am. Acad. 11: 84. 1876.
[21] Don, G. Gen. Hist. 4: 177. 1838.
[22] Humboldt, Bonpland & Kunth, Nov. Gen. & Sp. Pl. 3: 174. 1818.

publication for the first time. Kuntze,[23] in 1891, revived the generic name *Tetragonanthus* Gmelin. He has been followed by a few later taxonomists, among whom are Britton,[24] Small,[25] Rydberg,[26] and others. However, *Halenia* was placed on the list of *nomina conservanda*, and thus must be regarded as the correct name in accordance with the International Rules of Botanical Nomenclature. *Halenia crassiuscula* Robinson and Seaton[27] appeared in 1893. Britton,[28] in 1894, reduced *H. Brentoniana* Grisebach to a variety of *Tetragonanthus deflexus*, while in 1899 Fernald[29] placed *H. heterantha* Grisebach under *Halenia deflexa* var. *heterantha*. Other new species and new combinations appeared in rapid succession, due to the extensive collecting done during the period from 1890 to about 1920, by Conzatti, Pringle, Purpus, and others in Mexico, and Weberbauer in South America. Among these newly published species were: *Halenia candida* Ramirez,[30] 1895; *H. chlorantha* Greenman,[31] 1905; *H. bella, H. caespitosa* Gilg,[32] 1906; *H. Conzattii* Greenman,[33] 1912; *H. guatemalensis* Loesener, and *H. plantaginea* var. *latifolia* Loesener[34] (now *H. guatemalensis* var. *latifolia* (Loesener) Allen) 1913.

The type species up to this time had been called *H. sibirica*, the name given it by Börckhausen. However, according to the rules of priority, *sibirica* should give way to the older name *corniculata* used by Linnaeus. Accordingly, Druce[35] in 1914 revived *corniculata* which is at present the accepted name for the type species of *Halenia*. Britton and Brown in the 'Illustrated Flora,'[36] reduced Grisebach's species *Brentoniana* and *heterantha* to varieties of *deflexa*.

[23] Kuntze, Rev. Gen. Pl. 2: 431. 1891.
[24] Britton, Manual, 734. 1901.
[25] Small, Fl. Southeastern U. S. 931. 1913.
[26] Rydberg, Fl. Rocky Mts. 666. 1922.
[27] Robinson & Seaton in Proc. Am. Acad. 28: 113. 1893.
[28] Britton in Mem. Torrey Bot. Club 5: 261. 1894.
[29] Fernald in Rhodora 1: 37. 1899.
[30] Ramirez in Inform. Secret. Foment. Mexic. (Excurs. Mont. Ajusco). 34. 1895.
[31] Greenman in Proc. Am. Acad. 41: 240. 1905.
[32] Gilg in Fedde, Rep. Spec. Nov. 2: 52. 1906.
[33] Greenman in Publ. Field Mus. Bot. 2: 335. 1912.
[34] Loesener in Verh. Bot. Ver. Brandenb. 55: 182. 1913.
[35] Druce in Rept. Bot. Exch. Cl. Brit. Isles 3: 419. 1914.
[36] Britton & Brown, Ill. Fl. 3: 15. 1913.

Gilg,[37] in 1916, monographed the South American representatives of the genus, adding several new species. At that time, the herbarium at Berlin contained as complete a series of South American plants as were to be found anywhere, but, in some cases at least, the material was too inadequate to determine the limits of variation of certain of the species proposed. Hence, some of the species recognized, studied in the light of subsequent collections, have fallen into synonymy. Gilg created three main divisions:

A. Nectaria parva vel obsoleta, rarius extrinsecus breviter semigloboso-prominentia. Folia manifeste carnoso-subcoriacea.

B. Nectaria haud calcariformia, sed extrinsecus ad basin corollae alte globoso- vel coniformi-prominentia. Folia semper tenuiter herbacea.

C. Nectaria extrinsecus calcaria manifeste evoluta formantia.

Division A contains the largest known *Halenia*, native of South America only, which in inflorescence, flower, and leaf habit, shows affinities with the western species of *Swertia* and *Frasera* as well. Plants in division A are very distinct and occur in Colombia and Venezuela. These Gilg apparently considered the most primitive.

In division B we find the *brevicornis-parviflora* complex. Gilg considered *H. brevicornis* (HBK.) Don a valid species known only from South America, and *parviflora* a native of Mexico; he further described a new species *erythraeoides* from Venezuela which agrees in every respect with the *parviflora* type from Mexico.

Division C is subdivided according to the length of spurs; here again, confusion has occurred, as is apt to be the case when herbarium material is scanty and field work impossible. From a limited experience in the field with a North American species, the author can state with conviction that it is possible for two plants belonging to the same species, growing side by side, to vary not only in form but in size as well. It has been found also that the spur character is inconstant. Axillary flowers and those blooming late in the season frequently possess shorter spurs or no spurs at all. If this character is so variable in one species, it

[37] Gilg in Engl. Bot Jahrb. 54: Beibl. 118, p. 93. 1916.

is reasonable to suppose that the same situation may obtain in other species. Only close attention to ecological detail and a wealth of material not yet available from South America can enable the monographer to delimit species from these little-known regions even with a fair degree of accuracy.

Briquet,[38] in 1931, described several new species which will be treated below.

Gross Morphology

Habit.—The American species of the genus *Halenia* are glabrous, strictly herbaceous, or somewhat ligneous annuals or perennials. They may be of caespitose habit, as is illustrated by *H. caespitosa*, or coarse, fleshy, foliose plants with single stems, 5 or more dm. high, as in *H. hygrophila* and related species, or scapose with the basal leaves disposed in a rosette, as in *H. plantaginea*, or slender, graceful, simple or branching plants 1.5–6 dm. high, as in *H. brevicornis* and its varieties. As a whole, the genus is not colorful, the flowers being various shades of yellow and yellow-green, except in the northernmost species, which has purple flowers.

Roots.—The root system of the North American species is fibrous, with a persistent, slender tap-root, frequently more or less woody in texture, though typically that of an annual or perennial in cross-section. In the South American species the root is, for the most part, ligneous and thick.

Stems.—The stems are simple or branched, usually erect, though they may be decumbent, as in *Halenia decumbens* and *H. Weddelliana.* They are of two types, mostly foliose as in *H. deflexa* and *Schiedeana*, or scapose as in *H. plantaginea.* The stems often continue underground for a short distance, sending out erect, flowering stems at irregular intervals. These may be angular or terete; if the former they are often slightly winged, due to the decurrence of the leaves, and usually faintly striate.

Leaves.—The leaves are opposite and decussate, or infrequently whorled as in *H. verticillata*, either entirely cauline or disposed in a rosette, sessile or petiolate. The petioles exhibit the same characteristics as the stem, the decurrence of the calyx-lobes

[38] Briquet in Candollea 4: 317. 1931.

frequently being apparent. Where both petiolate and sessile leaves occur on the same plant, the basal leaves have petioles often equal to or longer than the blade, and the petioles become decreasingly shorter toward the summit of the stem, the uppermost leaves being sessile. The leaves are entire, 1-, 3- or 5-nerved, and range from ovate to obovate or spatulate, or lanceolate to linear, varying from .5 to 8 or 10 cm. in length and up to 6 cm. in width. The leaves of the North American species are, on the whole, thin and herbaceous, whereas in the South American species they are frequently coarse, fleshy, or coriaceous.

Inflorescence.—The inflorescence consists of terminal or axillary cymes of varying density. The flowers occur on short pedicels at the tip of a stem or branch in a compact cluster or head, as in *H. brevicornis*, or they may be borne loosely on long pedicels at the tip of a branch or at a node, as in *H. Schiedeana.* In the Central American and the more primitive of the South American species, the inflorescence is usually a spicate, racemose, or more or less umbellate cyme. A pair of small, linear, foliaceous bracts is usually present at the base of the inflorescence, often bearing tiny, undeveloped buds in their axils. Frequently the bracts approximate the leaves in size and structure, and in *H. involucrata* they form an involucre almost entirely enveloping the inflorescence.

Calyx.—The calyx is persistent, foliaceous, 4-parted, and the segments united only at the extreme base and arranged in pairs; the inner pair represents an inner cycle, the second an outer cycle. The segments may be caudate as in the type species, *H. corniculata*, or spatulate, obovate, elliptic, lanceolate-linear, or linear, with intergradations, with obtuse, acute, acuminate, mucronate or apiculate tips. The tips very rarely are reflexed, as in *H. Schiedeana.* The length of the calyx varies from one-third to nearly equal that of the corolla. The calyx-segments are from 1- to 3-nerved, often reticulately veined at the tip, and both surfaces are often papillate. Squamellae are usually found on the inner surface of the calyx-segments at their base (see fig. 1). They vary in size, shape, number, and position on the lobes, and

are usually distinguishable only under the dissecting lens after the herbarium specimens have been boiled. Squamellae occur in many of the *Contorti* both on the calyx and the corolla-lobes. Engler and Prantl[39] have referred to similar structures in several genera of the Gentianaceae as discs.

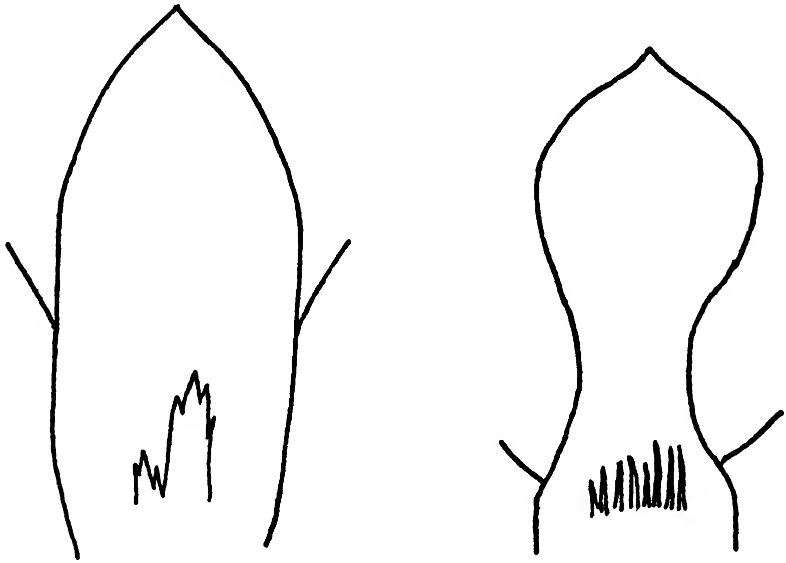


Fig. 1. Types of squamellae found on the calyx in the genus *Halenia*.

Corolla.—The corolla is marcescent, campanulate, 4-lobed, white, yellow, yellow-green, green, or purple, ranging in length from 5 mm. to nearly 3 cm. The lobes are triangularly ovate or obovate, acute, acuminate, apiculate, mucronate or obtuse, often auriculate, with an entire, erose, or crisped margin, and frequently papillate on both surfaces. The veining of the dextrorsely convolute lobes may or may not be reticulate. The corolla-tube varies from one-fourth to three-fourths the length of the entire corolla. At or near the base of the tube, opposite each lobe, is a tubercle which may be merely a slight swelling in the lower portion of the tube, as in *H. brevicornis*, or a definite

[39] Gilg in Engler & Prantl, Nat. Pflanzenfam. 4^2: 89. 1895.

spur longer than the corolla, as in *H. guatemalensis* (pls. 8–11). It frequently happens that the corolla lacks spurs entirely in the axillary flowers or in those occurring late in the season, as, for example, in *H. deflexa* and other species. Not only in *Halenia* is this situation apparent, but it is recalled that in other normally spurred plants, for example, *Linaria canadensis*, spurs are frequently absent. Therefore it has seemed advisable to discontinue *heterantha* as a variety of *H. deflexa*, since the occurrence of these spurless forms is more or less frequent within the genus. Gilg noted that in certain species of *Halenia*, for example, *H. brevicornis*, etc., the flowers on the main stalk are normally large and wide open, while below, on the same stem, they are definitely smaller, apparently not opening at all or else very slightly. The structure is similar, with the exception of the absence of spurs. The ovary in these abnormal flowers contains fewer seeds, and the capsule is much reduced in size. This would indicate, according to Gilg, a gradual reduction of chasmogamous flowers which depend on insect pollination, to more or less cleistogamous flowers. The shape of the spurs varies exceedingly, from slender to very thick and broad, or from spreading and ascending to pendulous and incurved. Intergrading forms are frequent. The spurs are frequently conspicuously veined and apparently glandular.

Stamens.—The stamens are equal in number to, and are borne alternate with, the lobes of the corolla at or near the summit of the tube. The filaments are adnate to the corolla, and the anthers are often enfolded in the bud by the margins of the corolla-lobe. The anthers are versatile, deltoid, ovate or oblong, often mucronate and papillate. The filaments are usually linear, but they may become more or less dilated and, rarely, papillate. The pollen grains are constant for the genus, being more or less tetrahedrally spherical, and having three pores.

Pistil.—The pistil is sessile. The stigma is usually sessile and cleft to expose the two inner stigmatic surfaces; the lobes may be truncate or ovate. The ovary is bicarpellate, the margins of each carpel being infolded and becoming the region of attachment for the numerous ovules.

Fruit.—The fruit is a flattened, lanceolate to lanceolate-

obovate capsule, frequently subfalcate, and usually exserted. It is unilocular at maturity, though in the young state it appears to be more or less two-celled. The fruit dehisces septicidally along the inner surface of each locule tip.

Seed.—The seeds vary in shape, being globose to ovoid or elliptic, often flattened. The surface is reticulate in the majority of the South American species and in the *brevicornis* complex, except for var. *latifolia.* The remaining species show the surface of the seeds to be minutely granular instead of reticulate. They vary in size from 0.5 to 1 mm. in diameter, and in color from dull greenish-brown and yellow-brown to dark, shiny brown, the latter usually being typical of those with reticulate surface. The age of the plant and the conditions attending its collection no doubt have their influence on the color, size, and, to some extent, the texture of the seed-coat.

Floral Anatomy

The major portion of the anatomical investigation of the Gentianaceae, particularly the Menyanthoideae, has been concerned with the stem and leaf structure. The most complete anatomical data is found in Gilg's treatment of the Gentianaceae in 'Die Natürlichen Pflanzenfamilien.'[40] Solereder's 'Systematic Anatomy of the Dicotyledons'[41] gives very little additional information. Since that time more attention has been given to floral morphology as a separate study. Stolt,[42] in 1921, made an exhaustive cytological survey of the flowers of several genera, among which was included *Halenia elliptica,* an Asiatic species having affinities with *Halenia deflexa* of North America. Incidentally, Stolt inserted a diagram of the transverse section through the ovary, which indicates clearly the vascular system of that portion of the flower.

In order to make the present monograph as complete as possible, anatomical study was undertaken. Fresh flowers of *Halenia deflexa,* a species with both spurred and spurless forms, were obtained by the author in Vermont and preserved in 70 per cent

[40] Gilg in Engler & Prantl, Nat. Pflanzenfam. 4^2: 50. 1895.
[41] Solereder, Systematic Anatomy of the Dicotyledons 1: 548–550. 1908.
[42] Stolt in K. Svensk. Vet.-Akad. Handl. 61^{14}: 1–56. 1921.

alcohol. The pickled material was dehydrated and embedded in paraffin following the butyl alcohol method outlined by Zirkle,[43] sectioned at 10 μ, and stained with crystal violet and erythrosin. The accompanying drawings (pl. 12) were made with the aid of a "Promi" microscopic drawing and projecting apparatus. The xylem has been cross-hatched in order to differentiate it from the other vascular elements.

Transverse sections of the spurred form of *Halenia deflexa* show that the vascular system of the pedicel is an amphiphloic siphonostele (pl. 12, fig. 1). Approaching the receptacle, the stele enlarges and assumes a rhombic form (fig. 2). The decurrence of the outer lobes of the calyx is apparent. Shortly thereafter (fig. 3), the midribs (a) of the two outer calyx-lobes leave the receptacular stele (r). They migrate outward, and from either, two lateral traces (a′) are given off (fig. 4). At this point, four lacunae (z) appear, prior to the severing of the calyx from the receptacle. In the succeeding illustration (fig. 5) these lacunae (z) merge into two crescent-shaped fissures, and the midribs of the two inner calycine lobes (b) leave the stele.

In fig. 6 the calyx-tube is entirely free from the receptacle, and in the axil of each potential lobe are visible 4–8 minute emergences or squamellae (e). The stele has again assumed a more or less rhombic shape, but from the 4 angles, traces (c) depart centrifugally, soon resolving into the midrib (n) and two laterals (c′) destined to supply each of the 4 corolla-lobes (fig. 7).

The disruption of the residual vascular cylinder is continued, and the 4 staminal traces (f) are fully differentiated. At this interval the corolla-tube is virtually free from the receptacle.

In the succeeding illustration (fig. 8) lacunae appear at m, the ovary at this point appearing bilocular. The residual stele consists of two roughly semi-circular masses with a concentration of lignified elements (l) at either end. The calyx-lobes are free, and sections near the tip of the reflexed spurs are found, the origin of which is to be described.

In the following illustration (fig. 9) the origin of the spurs is apparent, and a cleft (y) is visible, indicating the sinus. Simultaneously, 4 protrusions occur on the inner surface of the corolla,

[43] Zirkle in Science, N. S. 71: 103. 1930.

below the sinus, preparatory to the severing of the staminal filaments (f). The ventral traces (l) and dorsal (k) are discernible. The ovules (o) are evident, showing their position in the axils of the placentae (p).

In the final stage, taken from a section through the tip of the flower (fig. 10), the differentiation of the corolla-lobes and the isolation of the staminal filaments (f) are complete. The placentae (p) have diminished in size.

The spurless form shows a similar vascular system except for the absence of spurs, the presence of fewer ovules, and finally, a more pronounced dorsal trace (k), after the cessation of ovular production.

Geographical Distribution

The accompanying maps show three centers of distribution of the species of *Halenia* in America. The first (figs. 2, 4) extends from Labrador and Newfoundland, south to New York and west to British Columbia and Montana. The one species and its variety found in this area grow in moist or dry situations in calcareous, slaty, or alluvial soil, in open woods or fields, on stream banks or along the sea-shore, usually in the shade. The habit varies with the habitat. This distribution follows closely the northern region of glaciation, and coincides with the usual distribution areas of herbaceous species common in that territory. This same species has been collected three times in the State of Mexico, but has not been reported from the intervening region, a fact that might suggest a previously more continuous distribution of the species from the northern Rockies along the mountain ranges to the Mexican Sierras.

The second area comprises a region extending from the Chiricahua Mountains of New Mexico and Arizona, southward to Costa Rica in Central America. Here are a few wide-spread mountain species; but for the most part, they are endemics occurring in volcanic areas (fig. 3).

The third large center of distribution is the northern part of South America, where the genus is represented by a relatively large number of endemic species (fig. 5).

All of the North and Central American species, with the

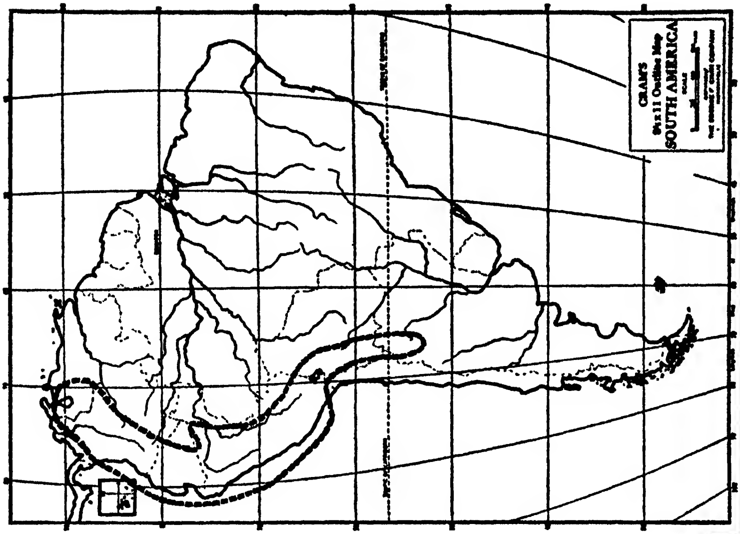


Fig. 5

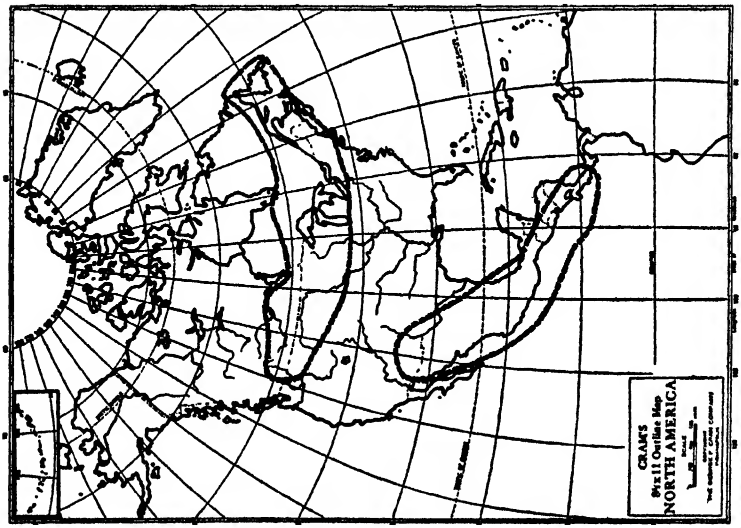


Fig. 4

Maps of North and South America, showing the principal areas of distribution of *Halenia*. Maps reproduced by permission of the George F. Cram Company).

exception of *Halenia alata* and *H. brevicornis* and its varieties, are spurred forms which show a definite relationship to one another. Those from South America are of two types: spurred type, similar to the North American species (excluding *brevicornis* and

alata) and showing affinities with them; non-spurred type, with tubercles instead of spurs and quite different in habit from the *brevicornis* and *alata*. *Halenia brevicornis* and its varieties form a connecting link between the second and third areas, as well as a morphological link, so to speak, between the primitive *Swertiella* and the more advanced *Haleniastrum*. The varieties of *brevicornis* do not extend further south than Guatemala, though the species proper is found in South America. Here again, as in Mexico and Central America, exist endemics which show a development almost parallel with that which has occurred north of the equator. An example of this is clearly shown by *Halenia decumbens*, from the mountains of Mexico, which bears a striking resemblance to *H. Weddelliana*, a species from Ecuador, Colombia, and Peru.

Systematic Position

The Gentianaceae, as pointed out by Gilg,[44] shows closer affinity to the Loganiaceae than to any other family in the Contorti, yet the differences are so well marked that the two families are never confused.

Grisebach separates the Gentianaceae into two subfamilies, the Gentianoideae and the Menyanthoideae. In the first subfamily the leaves are always simple, entire, sessile, and never alternate. The aestivation of the corolla is never valvate. The second subfamily, the Menyanthoideae, has alternate and mostly petiolate, sometimes trifoliate, leaves, and the aestivation is induplicate-valvate. *Halenia* belongs to the first division. The structures called squamellae, described early in the text, are never found in the Menyanthoideae but may occur in other genera of the Gentianaceae, at the base of the corolla or calyx-lobes.

The nearest relative of *Halenia* is *Swertia*. The most primitive forms of *Halenia*, particularly the South American species, are often confused with *Swertia*. The primitive members of *Halenia*, instead of the definitely spurred corolla typical of the majority of the species of the genus, possess small, knob-like protuberances or nectaries which upon casual examination might pass unnoticed

[44] Gilg in Engler & Prantl, Nat. Pflanzenfam. 4^2: 50. 1895.

or be taken for the nectaries which are structurally distinct and characteristic of *Swertia*. More detailed study reveals the fact that the depressions or spurs of *Halenia* are without the marginal fringe which is always conspicuous in *Swertia* (fig. 6). *Halenia* never has a corona, but in *Swertia* it is frequently present. The corolla-lobes of *Halenia* are dextrorsely convolute in the bud, whereas the reverse is the case in *Swertia*. Anatomical study discloses other generic differences.

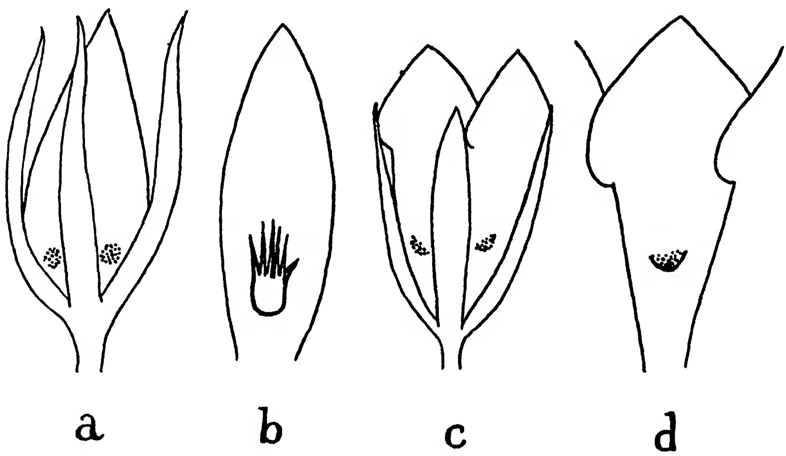


Fig. 6. *Swertia perennis* L.: *a*, bud; *b*, interior surface of petal. *Halenia brevicornis* (HBK.) Don: *c*, bud; *d*, interior surface of petal.

Within the genus itself two rather distinct sections are apparent. The more primitive, which was mentioned above as being near *Swertia* and possibly originating from it, may be called tentatively *Swertiella*. It contains those species from South America which were considered by Gilg as being most primitive. *Halenia alata* of Mexico also belongs to this section. The *Swertiellae* may be characterized by the absence of spurs or the presence of small tubercles or prominences at the base of the corolla, which are not visible usually from the outside. They are coarse, fleshy, foliose plants, and for the most part with dense inflorescences. The second section, *Haleniastrum*, is more advanced and is readily recognized by the presence of spurs of varying

length and shape. Both herbaceous and more or less woody types comprise this section.

An interesting discussion of the phylogeny of the Gentianaceae was presented by T. H. Huxley[45] before the Linnaean Society of London, April 7, 1887. Confining his study to the structure of the corolla, he separated the family into two groups; the first division *Permelitae* was segregated mainly on the presence of a series of nectarial cells on the inner surface of the cup. The *Permelitae* were again divided into four groups with various

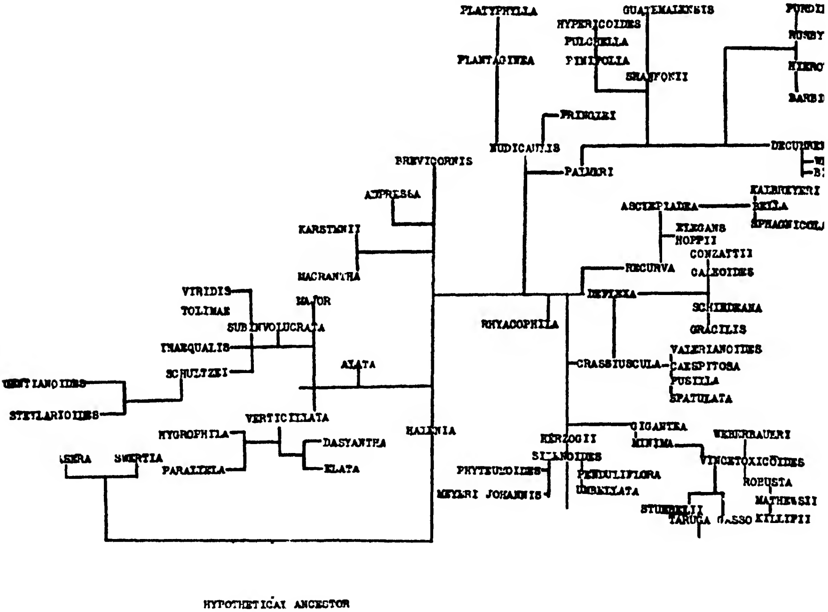


Fig. 7. Chart showing the probable phylogenetic relationship of species of *Halenia.*

modifications of floral structure. The first, *Actinanthe,* which he considered the most primitive and the least differentiated, contained among other elements, *Exadenus.* The latter was included as a transitional stage on account of its rudimentary spurs, leading to the second division, the *Keratanthe,* containing only one genus *Halenia,* which represents an extreme modification of the *Exadenus* type. The third related division, the *Lophanthe,*

[45] Huxley, T. H. Jour. Linn. Soc. Bot. 24: 101. 1887.

depicts another outgrowth of the *Actinanthe* type, but with filamentous appendages or fimbriae. *Swertia* and *Frasera* fall into this category.

Text-figure 7 shows the probable relationship of the various species of *Halenia*, according to the author's interpretation.

For the sake of convenience, in the taxonomic treatment of the genus, the North and South American species are taken up separately in each section.

Abbreviations

In the citations of specimens examined the following abbreviations have been used to denote the various herbaria from which specimens were used for study.

ANSP	= Herbarium of the Academy of Natural Sciences of Philadelphia.
BG	= Botanical Garden, Berlin.
BB	= Brooklyn Botanical Garden.
BM	= British Museum of Natural History, London.
B	= Herbarium of the Botanical Garden, Brussels.
C	= Herbarium of the University of Chicago, deposited in the Field Museum of Natural History.
CAS	= Herbarium of the California Academy of Sciences.
D	= Dudley Herbarium of Leland Stanford Jr. University.
DH	= Delessert Herbarium of Geneva.
F	= Herbarium of the Field Museum of Natural History.
G	= Gray Herbarium of Harvard University.
HP	= Herbarium of H. Pittier, Director de Museo Comercial, Caracas, Venezuela.
HJP	= Herbarium of the Jardin des Plantes, Paris.
IAC	= Herbarium of the Iowa Agricultural College.
K	= Herbarium of the Royal Botanic Gardens, Kew.
L	= Linnaean Herbarium, Linnaean Society of Botany, London.
M	= Herbarium of the Missouri Botanical Garden.
MU	= Herbarium of the University of Missouri.
NY	= Herbarium of the New York Botanical Garden.
P	= Parry Herbarium deposited at the Iowa Agricultural College.
S	= Herbarium of the Botanical Museum, Stockholm.
SM	= Herbarium of the State Museum, Albany, New York.
UC	= Herbarium of the Botanical Museum of the University of Copenhagen.
US	= United States National Herbarium.
V	= Herbarium of the Natural History Museum, Vienna.

Taxonomy

Halenia Börckh. in Roemer, Arkiv für Botanik 1[1]: 25. 1796; Ruiz & Pavon, Fl. Peruv. 3: 21, *pl. 242, fig. 1.* 1802; Endl. Gen. Pl. 601. 1836–40; Grisebach, Obs. Gent. 36. 1836; G. Don, Gen.

Hist. **4**: 177. 1838; Grisebach, Gen. & Sp. Gent. 322. 1839; Dietrich, Syn. Pl. **2**: 918. 1840; Hooker, Fl. Bor.-Am. **2**: 67, *pl. 155–6*. 1840; Grisebach in DC. Prodr. **9**: 128. 1845; Grisebach in Linnaea **22**: 45. 1849; Weddell, Chlor. And. **2**: 74. 1859; Benth. & Hooker, Gen. Pl. **2**: 817. 1876; Hemsl. Biol. Cent.-Am. Bot. **2**: 351. 1882; Baillon, Hist. Pl. **10**: 142. 1891; Gilg in Engler & Prantl, Nat. Pflanzenfam. 4^2: 89. 1895; Conzatti, Fl. Syn. Mexico, 174. 1897; Rouy, Ill. Pl. Eur. **17**: *pl. 412*. 1902; Gilg in Fedde, Rep. Spec. Nov. **2**: 52. 1906; Robinson in Gray's Manual, ed. 7. 659. 1908; Britton & Brown, Ill. Fl. **3**: 15, *fig. 3365*. 1913; Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 93. 1916; Johnson, Tax. Fl. Pl. 488. *fig. 340*. 1931; Briquet in Candollea **4**: 317. 1931; Rydberg, Fl. Cent. N. Am. 636. 1932.

Tetragonanthus Gmelin, Fl. Sib. **4**: 114, *pl. 53*. 1769; Kuntze, Rev. Gen. Pl. **2**: 431. 1891; Britton, Manual, 734. 1901; Small, Fl. Southeastern U. S. 931. 1913; Rydberg, Fl. Rocky Mts. 666. 1922.

Swertia Linnaeus, Amoen. Acad. **2**: 344. 1751; Jussieu, Gen. Pl. 158. 1791; Michaux, Fl. Bor.-Am. **1**: 97. 1803; Humboldt, Bonpland & Kunth, Nov. Gen. & Sp. Pl. **3**: 174. 1818; Kunth, Syn. Pl. **2**: 266. 1823; Schlectendal & Chamisso in Linnaea **5**: 122. 1830.

Ceratia Persoon, Syn. Pl. **1**: 287. 1805; Hedw. Gen. 181. 1806.

Exadenus Grisebach, Obs. Gent. 36. 1836; Gen. & Sp. Gent. 322. 1839; in DC. Prodr. **9**: 128. 1845.

Glabrous caulescent annual, biennial, or perennial herbs. Root fibrous, varying from typically herbaceous to extremely ligneous. Leaves membranaceous or fleshy, opposite, entire, sessile or petiolate, usually 3–5-veined, veins frequently submerged in fleshy type. Inflorescence a terminal or axillary, subumbellate, or rarely racemose or spicate cyme. Calyx 4-parted, foliaceous, linear, lanceolate, ovate or spatulate, usually papillate, often bearing small squamellae at the base of each lobe. Corolla 4-parted, white, yellow, green, or purple, marcescent, campanulate, the tube of varying length; the lobes dextrorsely convolute, elliptic to ovate, obtuse to acute or apiculate, entire, crisped or erose, frequently auriculate and papillate. Stamens

4, included, adnate to the corolla-tube at varying heights, and alternate with the corolla-lobes; filaments linear, occasionally somewhat dilated; anthers 2-celled, ovate, oblong or subtriangular, versatile. Carpels 2, sessile, the edges being infolded to form a parietal placenta bearing many ovules; stigma sessile, composed of two oblong or ovate lobes, the inner surfaces of which are stigmatic. Fruit a compressed capsule, lanceolate to ovate, often subfalcate, septicidially dehiscent from the tip. Seeds globose or slightly flattened, brown or greenish tan, granular or reticulate.

Type species: *H. corniculata* (L.) Druce in Rept. Bot. Exch. Cl. Brit. Isles **3**: 419. 1914.

Synopsis of the Sections of the Genus

Plants usually coarse with fleshy leaves, rarely slender with thin, herbaceous leaves; stem usually leafy; spurs absent, or present as very small inconspicuous protuberances, frequently obscured by calyx; distribution chiefly South America.......... *1. Swertiella*

Plants usually slender, with thin, herbaceous leaves; stem leafy or scapose; spurs present; distribution North and South America.......... *2. Haleniastrum*

Section 1. Swertiella

KEY TO NORTH AMERICAN SPECIES AND VARIETIES

1. Leaves mostly radical; stem more or less scapose.......... *1. H. alata*
1. Leaves mostly cauline; stem not scapose.
   2. Leaves ovate, less than 1.2 cm. long.......... *2f. H. brevicornis* var. *ovata*
   2. Leaves not ovate, longer than 1.2 cm.
      3. Pedicels filiform, slender, elongate; habit decidedly spreading.......... *2g. H. brevicornis* var. *Tuerckheimii*
      3. Pedicels stouter than filiform, shorter.
         4. Corolla without distinct spurs.
            5. Inflorescence strict.......... *2c. H. brevicornis* var. *micranthella*
            5. Inflorescence compact.
               6. Leaves linear, slender.......... *2. H. brevicornis*
               6. Leaves ovate to lanceolate, coarse.......... *2a. H. brevicornis* var. *latifolia*
         4. Corolla with small, but distinct spurs.
            5. Spurs thick, conical, more or less pendulous.......... *2b. H. brevicornis* var. *multiflora*
            5. Spurs blunt, spreading, squarrose.......... *2e. H. brevicornis* var. *chihuahuensis*
            5. Spurs slender, divergent.......... *2d. H. brevicornis* var. *divergens*

1. **H. alata** (Mart. & Gal.) Hemsl. Biol. Cent.-Am. Bot. **2**: 351. 1882.

Exadenus alatus Mart. & Gal. Bull. Acad. Brux. **11**[1]: 372. 1844; Walper's Rep. Bot. Syst. **6**: 508. 1846–7.

Tetragonanthus alatus Kuntze, Rev. Gen. Pl. **2**: 431. 1891.

Small perennial with 1–2 simple erect slightly winged stems, about 0.5–1 dm. high; numerous radical leaves, up to 3.5 cm. long and .4 cm. broad, crowded, attenuate into long petioles, oblanceolate, obtuse, 3-nerved; lower cauline leaves almost twice the length of the radical, subsessile; upper linear, obtuse, sessile; inflorescence consisting of a few (4–6) terminal flowers on 4-winged pedicels; calyx foliaceous, slightly shorter than corolla, segments oblong, 3-nerved, papillate, acute; corolla yellow, subrotate, up to .6 cm. long, tube about one-half as long as the entire corolla; corolla-lobes ovate, obtuse; filaments linear; anthers ovate; capsule broadly ovate; seeds yellow-brown, globose, granular.

Distribution: rocky forests of southern Mexico.

Specimens examined:

VERA CRUZ: in forests and on trachytic rocks on Mt. Orizaba, alt. 2250–3000 m., June–Oct. 1840, *Galeotti 7221* (BG, B TYPE, DH, K, V); Mt. Orizaba, alt. 3000–3125 m., Aug. 1838, *Linden 934* (DH, K).

2. **H. brevicornis** (HBK.) G. Don, Gen. Hist. **4**: 177. 1838; Wedd. Chlor. And. **2**: 77. 1859; Hemsl. Biol. Cent.-Am. Bot. **2**: 352. 1882; Gilg in Engler & Prantl, Nat. Pflanzenfam. **4**^{2}: 89. 1895.

Swertia brevicornis HBK. Nov. Gen. & Sp. Pl. **3**: 174. 1818.

S. parviflora HBK. Nov. Gen. & Sp. Pl. **3**: 174. 1818.

S. parviflora var. *α angustifolia* Sch. & Cham. in Linnaea **5**: 122. 1830.

S. cucullata Sessé & Mociño, Fl. Mex. 79. 1894.

Halenia parviflora G. Don, Gen. Hist. **4**: 177. 1838; Wedd Chlor. And. **2**: 77. 1859; Hemsl. Biol. Cent.-Am. Bot. **2**: 352. 1882.

H. paucifolia Hemsl. Biol. Cent.-Am. Bot. **2**: 352. 1882.

H. erythraeoides Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 105. 1916.

Exadenus parviflorus Griseb. Gen. & Sp. Gent. 322. 1839.

E. brevicornis Griseb. *l. c.* 323.

E. paucifolius Mart. & Gal. Bull. Acad. Brux. **11**^{1}: 372. 1844.

Tetragonanthus paucifolius Kuntze, Rev. Gen. Pl. **2**: 431. 1891.

T. parviflorus Kuntze, *l. c.*

T. brevicornis Kuntze, *l. c.*

Annual, 1.5–4.5 dm. high; root slender; stems erect, slender, usually simple below and branched above, sometimes branched from the base, slightly angled, and striate; leaves sessile, subconnate, lower linear to lanceolate, up to 3 cm. long, .4 cm. broad, usually prominently uninerviate, upper shorter, narrower, up to 2 cm. long, linear; inflorescence compact cymose clusters, pedicels erect, 1.8 cm. or less in length; calyx-segments lanceolate, approximately one-half to two-thirds the length of the corolla, usually 3-nerved; corolla .4–.8 cm. long, tube one-half or slightly more the length of the entire corolla; corolla-lobes broadly to narrowly ovate, acute, more or less auriculate; spurs merely small depressions near the base of the corolla-tube, usually not visible to the naked eye; stamens about .2 cm. long, attached usually near the middle of the tube; filaments linear, anthers usually deltoid; ovary lanceolate, about .5 cm. long; seeds minute, ovoid to subglobose, brownish, finely reticulate.

Distribution: chiefly in mountains, from Mexico, southward to Peru.

Specimens examined:

MEXICO:

SAN LUIS POTOSI: Oct. 1879, *Schaffner 421* (BG, BM, F, NY, UC, US); region of San Luis Potosi, alt. 1500–2000 m., 1878, *Parry & Palmer 600* (ANSP, BM, F, G, IAC, K, M, NY, US).

VERA CRUZ: Mt. Orizaba, alt. 1875 m., 1841–43, *Liebmann 10775* (UC); same locality and date, alt. 2500 m., *Liebmann 10778* (UC); same locality, 1840, *Galeotti 7219* (B TYPE of *Exadenus paucifolius*, DH); "in dumetis prope Jalapam," 1830, *Schiede & Deppe 247a* (BG TYPE of *Swertia parviflora* var. *α angustifolia*, BM, M).

GUANAJUATO: near city Guanajuato, alt. 1650 m., *Humboldt & Bonpland* (BG TYPE not seen, HJP, M photo.).

PUEBLA: vicinity of Puebla, ravines, Hacienda Alamos, route Vera Cruz, alt. 2170 m., Nov. 5, 1907, *Arsène 2098* (G, M, US); mountains, Esperanza, Aug. 1907, *Purpus 2697* (BG, BM, CAS, F, M, US); Chinantha, alt. 1750–2000 m., May 1841, *Liebmann 10776* (NY, UC).

MEXICO: La Cima, alt. 2500 m., "Jajalpa," alt. 1500 m., Aug. 1904, *Kuntze 23783* (NY); Volcan de Toluca, *Heller 401* (V).

CHIAPAS: 1864–70, *Ghiesbreght 137* (G, K, NY); *Ghiesbreght 618* (G, K, M).

MEXICO WITHOUT LOCALITY: *Tate* (DH); Oct. 8, 1897, *Berlandier 1207 ex 13* (DH); *Berlandier 1207* (V); *Pavon* (DH); *Wawra 425* (V).

CENTRAL AMERICA:

COSTA RICA: "in monte Reventado," alt. 2250 m., coll. of 1847, *Oersted 10779* (UC).

NICARAGUA: El Viejo, *Oersted* (M).

2a. H. brevicornis var. latifolia (Sch. & Cham.) Allen, n. comb.

Swertia parviflora var. *β latifolia* Sch. & Cham. in Linnaea **5**: 122. 1830.

Exadenus parviflorus var. *β latifolius* Griseb. Gen. & Sp. Gent. 322. 1839; in DC. Prodr. **9**: 128. 1845.

Halenia parviflora var. *latifolia* Hemsl. Biol. Cent.-Am. Bot. **2**: 351. 1882.

A more sturdy plant than the species, attaining a height of 6 dm.; leaves larger than species, 1.5–4 cm. long, .3–1.5 cm. broad, acute or obtuse, lowermost smaller, ovate, rotund, and with longer petioles; inflorescence frequently less compact than that of species and with longer pedicels; calyx-segments lanceolate, foliaceous, one-half to two-thirds the length of the corolla, papillate, 3-nerved; corolla .6–.8 cm. long, tube about equalling the ovate, frequently papillate, auriculate lobes; spurs short, consisting of very slight angular protrusions from the extreme base of the corolla-tube, giving the corolla a square appearance.

Distribution: mountains of Mexico.

Specimens examined:

Vera Cruz: "in dumetis prope Jalapam," 1830, *Schiede & Deppe 247b* (BG type of *Swertia parviflora* var. *β latifolia* Sch. & Cham., BM, M, S, V); same locality, coll. of 1833, *Beyrich* (S); region of Orizaba, Oct. 20, 1866, *Bourgeau 3126* (BG, B, K, S, UC, US).

Puebla: Manzanilla, alt. 2250 m., Nov. 24, 1908, *Arsène 1703* (B, US); Barrancas, Hacienda Alamos, route Vera Cruz, alt. 2170 m., Dec. 10, 1907, *Arsène* (M, US); Boca del Monte, alt. 2300 m., Nov. 16–19, 1907, *Arsène* (US).

Morelos: Lecima, Sierra de Ajusco, Aug. 18, 1896, *Harshberger 137* (ANSP, G, US).

Tlaxcala: Chiautempan, alt. 2250 m., Nov. 10, 1908, *Arsène 1711* (B, US).

Mexico: Ajusco Mountains, 1905, *Lemmon & Lemmon* (CAS); Valley of Mexico, *Lemmon* (CAS); Ixtaccihuatl, Jan. 1903, *Purpus* (CAS); Salto de Agua, Nov. 1905, *Purpus 1762* (CAS, F, G, M, US); Sierra de las Cruces, alt. 2375 m., Sept. 12, 1904, *Pringle 13120* (BG, F, G, K, S, UC, US); Eslava, *Salazar* (US); near Salazar, Sept. 14, 1903, *Rose & Painter 7026* (US); Désierto Viejo, near Mexico, Sept. 6, 1865, *Bourgeau 799* (BG, B, DH, G, K, NY, S, UC, US).

Michoacan: vicinity of Morelia, alt. 2500 m., Oct. 26, 1911, *Arsène 5610* (M, US).

Mexico without Locality: *Berlandier 1207* (DH); 1832, *Alaman* (DH).

2b. H. brevicornis var. **multiflora** (Benth.) Allen, n. comb.

Halenia multiflora Benth. Pl. Hartw. 24. 1839.

Plant more sturdy than the species, frequently branched above, rarely branched at the base, 4.5 dm. or less high; leaves up to 1.3–2.5 cm. long, .2–.9 cm. broad, obtuse or acute, ovate to

narrowly lanceolate, frequently faintly 3-nerved, midvein always prominent; inflorescence usually densely flowered, though compactness of arrangement varies; mature corolla with small thick rounded pendant spurs at its base.

Distribution: in mountains of Mexico.

Specimens examined:

San Luis Potosi: in mountains of San Miquelito, Aug. 1877, *Schaffner 38* (G); Alvarez, Sept. 28–Oct. 3, 1902, *Palmer 160* (CAS, F, G, M, NY, UC, US); *Parry & Palmer 600b* (IAC, M).

Zacatecas: on the Sierra de los Morones, near Plateado, Sept. 1, 1897, *Rose 2732* (US).

Jalisco: "in pinetis Bolaños," 1839, *Hartweg 210* (BM, DH, G, K, NY, V); Sierra Madre, west of Bolaños, Sept. 15–17, 1897, *Rose 2962* (US); banks of ravines near Guadalajara, alt. 1250 m., Oct. 21, 1903, *Pringle 11636* (BG, F, G, K, US); hills near Guadalajara, Oct. 14, 1889, *Pringle 2735* (C, IAC); Rio Blanco, Oct. 1886, *Palmer 680* (G, NY, US); same locality and date, *Palmer 683* (G).

Guerrero: between Ajusinapa and Petatlan, alt. 1250–1750 m., Dec. 14, 1894, *Nelson 2126* (US).

Oaxaca: Sierra de San Felipe, alt. 2000 m., Oct. 13, 1894, *Smith 665a* (M, NY, US); same locality, alt. 1800 m., Aug. 15, 1898, *Conzatti & Gonzalez 878* (G); San Pedro Nolasco, alt. 1875 m., Oct. 1840, *Galeotti 1490* (B, DH).

2c. **H. brevicornis** var. **micranthella** (Briq.) Allen, n. comb.

Halenia micranthella Briq. in Candollea **4**: 320. 1931.

Plant 1.5–6 dm. high; leaves linear-lanceolate, often obtuse, 3-nerved, the lower long-petiolate, the upper linear, sessile; inflorescence usually less compact, but more strict, than in the species, and the stem and pedicels more erect; the nodes of the inflorescence approximately equidistant, giving the appearance of a narrow raceme; corolla campanulate, but more narrowed at the base than in the species; calyx-segments usually one-half the length of the corolla; corolla-lobes broadly ovate, acuminate, auriculate; spurs reduced to minute depressions, frequently not visible to the naked eye; anthers usually broadly ovate; filaments varying, usually linear, rarely dilated.

Distribution: mountains of Mexico.

Specimens examined:

Hidalgo: El Chico, near Pachuca, Sept. 1905, *Purpus 1761* (CAS, F, G, M, NY, US); wet meadows, Sierra de Pachuca, alt. 2450 m., Aug. 13, 1898, *Pringle 6964* (ANSP, BG, B, CAS, DH, F, G, IAC, K, M, NY, S, US, V); same locality, Sept. 8, 1899, *Pringle 7943* (BG, F, G, K, M, NY).

Mexico: Sierra de Ajusco, Nov. 9, 1903, *Pringle 11842* (BG, F, G, K, S, UC, US); near Ozumba, alt. 2000 m., Nov. 3, 1902, *Pringle 11329* (G, UC, US).

South Mexico without Locality: July 1841, *Liebmann 10777* (UC).

Briquet based his new species on *Pringle 6964*. This is cited in the original publication as *1964*, but this is merely a typographical error. The Pringle specimens are about 12 cm. high. The additional material cited above undoubtedly belongs to the same species based on *Pringle 6964*, but for the most part it consists of plants over 15 cm. in height.

It is possible that there are two distinct plants under *Purpus 1761*, but since the variation in the *brevicornis* complex, as a whole, is so pronounced, these differences have been considered as variations typical of the variety. Hence, all sheets of *Purpus 1761* have been determined as var. *micranthella*.

2d. H. brevicornis var. **divergens**[46] Allen, n. var.

Similar to var. *multiflora* but with more slender spurs which diverge, making the corolla broader at the base than at the tip.

Distribution: central Mexico.

Specimens examined:

MICHOACAN: Loma Sta. Maria, vicinity of Morelia, alt. 2000 m., Sept. 4, 1910, *Arsène 55* (F); vicinity of Morelia, near La Huerta, alt. 1950 m., Sept. 1, 1910, *Arsène* (M TYPE, US); Loma Sta. Maria, alt. 2050 m., Sept. 19, 1910, *Arsène* (M, US); same locality, alt. 1950 m., Sept. 4, 1910, *Arsène 5957* (K, M, S, US); same locality, Oct. 28, 1910, *Arsène 5864* (K, M, US).

VERA CRUZ: Orizaba, 1853, *Müller* (NY).

MEXICO WITHOUT LOCALITY: 1858, *Sumichrast* (DH).

2e. H. brevicornis var. **chihuahuensis**[47] Allen, n. var.

Similar to var. *multiflora* but with lower leaves always elliptic-ovate, about 1 cm. long, increasing in length and acuteness and decreasing in width as they approach the summit of the stem; inflorescence more loosely arranged, and spurs more blunt but not quite so pronounced as in *multiflora;* calyx-segments three-fourths the length of the corolla, and usually narrower.

[46] **H. brevicornis** var. **divergens** Allen, var. nov.—Differt a var. *multiflora* calcaribus tenuioribus divergentibus latioribus basi quam summo.—MICHOACAN: vicinity of Morelia, near La Huerta, alt. 1950 m., Sept. 1, 1910, *Arsène* (M TYPE, US).

[47] **H. brevicornis** var. **chihuahuensis** Allen, var. nov.—Differt a var. *multiflora* foliis inferioribus semper elliptico-ovatis ca. 1 cm. longis, prope summum caulis longitudine augmentibus et latitudine deminuentibus; inflorescentia laxiora; calcaribus obtusis; calycis segmentibus ¾ corollae longitudini adaequantibus, plerumque angustioribus.—CHIHUAHUA: pine plains, base of the Sierra Madre, Sept. 26, 1888, *Pringle 1664* (BG, BM, B, CAS, DH, M TYPE, S, V).

Distribution: mountains of Chihuahua, Mexico.
Specimens examined:
CHIHUAHUA: pine plains, base of the Sierra Madre, Oct. 4, 1887, *Pringle 1330* (ANSP, CAS, F, G, K, NY, US); same locality, Sept. 26, 1888, *Pringle 1664* (BG, BM, B, CAS, DH, M TYPE, S, V); mesa, west of Hop Valley, Sierra Madre Mountains, alt. 1750 m., Sept. 17, 1903, *Jones* (BM, M, US); southwestern Chihuahua, Aug.–Nov., 1885, *Palmer 403* (ANSP, G, IAC, K, NY, US).

2f. H. brevicornis var. **ovata**[48] Allen, n. var.

Plant 5–6 dm. high; stems erect, simple below, bearing short floriferous branches only at tip; leaves about 12 pairs, shortly petiolate, frequently bearing buds in the axis; lower leaves broadly ovate, usually with a prominent midvein, reticulate, less than .5 cm. long, .3–.4 cm. broad, abruptly acuminate; middle cauline leaves ovate, 1–1.2 cm. long, .7–.8 cm. broad, acuminate; upper leaves up to 1.5 cm. long, lanceolate; inflorescence and flowers similar to *multiflora* type, but spurs more slender, slightly incurved, and divaricate.

Distribution: known only from type locality.
Specimens examined:
MEXICO: Tepic, Jan. 5–Feb. 6, 1892 *Palmer* (US TYPE).

2g. H. brevicornis var. **Tuerckheimii** (Briq.) Allen, n. comb.

Halenia Tuerkheimii Briq. in Candollea **4**: 317. 1931 (dedicated to H. von Tuerckheim).

Slender graceful stem, loosely branching, up to 6 dm. high; leaves lanceolate to linear-lanceolate or elliptic, about 1 cm. long, .5 cm. broad, lower cauline leaves becoming more acute, faintly 3-nerved, midvein prominent; middle cauline leaves 3 cm. or less long, .5 cm. broad; inflorescence in loose, terminal or axillary, few-flowered cymes, each flower borne on a long slender attenuate pedicel; first flowers with very small, though definitely formed, spurs, at the base of the corolla-tube; later and usually axillary flowers of more slender habit and without spurs.

[48] **H. brevicornis** var. **ovata** Allen, var. nov.—Planta 5–6 dm. alta; caulibus erectis, infra simplicibus modo summo ramos breves floriferos gerentibus; foliis ca. 12 geminis, breve petiolatis, saepe in axibus gemmas gerentibus; foliis inferioribus late ovatis, medio-nervo plerumque prominenti, reticulatis, minusquam .5 cm. longis, .3–.4 cm. latis, abrupte acuminatis, foliis mediis caulinis 1–1.2 cm. longis, .7–.8 cm. latis, ovatis, acuminatis; foliis superioribus usque ad 1.5 cm. longis, lanceolatis; inflorescentia et floribus *multiflorae* similibus sed calcaribus tenuioribus, parvulum incurvatis divaricatisque.—MEXICO: Tepic, Jan. 5–Feb. 6, 1892, *Palmer* (US TYPE).

Distribution: known only from type locality.
Specimens examined:
GUATEMALA: "Alta Verapaz, Fichtenwälder bei San Joaquin," alt. 1000 m., Dec. 1907, *von Tuerckheim 2041* (F, DH, G, NY, US, V).

From an examination of the types of *Halenia brevicornis*, *H. parviflora*, *H. multiflora*, and *Exadenus paucifolius*, etc., it appears that this group presents a complex, all members of which show variation in habit and spurs, which can not be considered specific differences but differences of degree. Careful perusal of the specimens available discloses the fact that nearly every locality produces some variation in the species. Thus, Chihuahua gives rise to a definitely spurred form, while Guatemalan material presents an entirely different aspect habitally. Ecological experiments, as well as field work, would doubtless prove highly valuable as a supplement to the taxonomic treatment of this complex. At present there is no distinction which warrants the retention of these as distinct entities. To draw a line between these forms mentioned and treat them specifically would complicate further an already confused situation. Therefore it has seemed advisable to draw attention to these differences, or variations from the specific form, by relegating them to the status of variety of form, with the note that this is merely an arbitrary disposal, that intergradation is existent and that environment is in a large measure responsible for the variation found within the species.

KEY TO THE SOUTH AMERICAN SPECIES

1. Leaves always thin, herbaceous; stem and branches more or less slender.
  2. Plant slender; flowers in anthesis less than 1 cm. long.
    3. Stem usually branched above, sparingly leafy; basal rosette absent... .... *2. H. brevicornis*
    3. Stem not branched above, leafy; leaves adpressed; basal rosette present........ *3. H. adpressa*
  2. Plant coarse; flowers in anthesis usually more than 1 cm. long.
    3. Nodes 8 or less; leaves not apiculate........ *4. H. macrantha*
    3. Nodes 12 and more; leaves apiculate........ *5. H. Karstenii*
1. Leaves more or less fleshy; stem and branches coarse.
  2. Upper leaves of inflorescence subinvolucrate and bearing flowers....... .... *6. H. subinvolucrata*
  2. Upper leaves of inflorescence not subinvolucrate.
    3. Rosette usually present; stem-leaves linear-lanceolate.
      4. Plant usually less than 30 cm. high; leaves not more than 5 cm. long.
        5. Calyx-lobes minutely hirtellous.

6. Plant usually less than 20 cm. high, or if more than 20 cm. high, flowers in axils of all cauline leaves................*7. H. inaequalis*
6. Plant 10–30 cm. high; flowers in axils of upper leaves only.... ....*8. H. viridis*
5. Calyx-lobes not hirtellous.
6. Stem-leaves less than 3 pairs, linear................*9. H. Schultzei*
6. Stem-leaves more than 3 pairs, lanceolate to linear-lanceolate.
7. Cauline leaves less than 2 cm. long............*10. H. gentianoides*
7. Cauline leaves more than 2 cm. long..........*11. H. stellarioides*
4. Plant usually more than 30 cm. high; leaves more than 5 cm. long.
5. Inflorescence verticillate; leaves ternate............*12. H. verticillata*
5. Inflorescence not verticillate; leaves not ternate.
6. Nodes more than 12............................*13. H. foliosa*
6. Nodes less than 12.
7. Root-stalk swollen, conspicuously larger than stem.
8. Flowers more than 1.5 cm. long, 8–10 mm. broad........ ....*14. H. dasyantha*
8. Flowers less than 1.3 cm. long, 5–7 mm. broad......*15. H. elata*
7. Root-stalk not swollen, scarcely larger than stem.
8. Plant less than 30 cm. high...................*16. H. Tolimae*
8. Plant more than 30 cm. high.
9. Inflorescence elongate, spicate; calyx-venation conspicuous.............................*17. H. hygrophila*
9. Inflorescence spreading; calyx-venation prominently ribbed................................*18. H. parallela*
3. Rosette absent; stem-leaves ovate to ovate-lanceolate........*19. H. major*

2. Halenia brevicornis (HBK.) G. Don, Gen. Hist. **4**: 177. 1838.

For synonymy and description, see North American species, page 140 of this work.

Specimens examined:

South America:

Venezuela: Trujillo & Mérida, alt. 1300–4900 m., 1842, *Linden 456* (DH).

Colombia: Bogota, Dec. 19, 1853, *Holton 19* (*464*) (NY); Dept. Cundinamarca, moist grassy loam, southwest of Sibate, alt. 2600–2800 m., Oct. 13–15, 1917, *Pennell 2434* (M, NY, US); Dept. Antioquia, La Sierra, Medellin, alt. 2000 m., Jan. 4, 1931, *Archer 1348* (M); Dept. El Cauca, open banks near Rio Cauca, Coconuco to Popayan, alt. 2000–2500 m., June 18, 1922, *Killip 6889* (US); field, near Rio San Andreas, Calaguala, Coconuco, alt. 2500–2800 m., June 18, 1922, *Pennell 7154* (ANSP, G, NY, US); field, north of Coconuco, alt. 2300–2500 m., June 11, 1922, *Pennell & Killip 6480* (ANSP).

Ecuador: near Quito, coll. of 1859, *Jameson* (DH, G, NY, UC, V).

Peru: steep grassy slopes, Mito, alt. 3000 m., April 8–18, 1923, *Macbride 3431* (F, M); 1840, *Mathews 3133* (DH).

Attention should be called to the fact that the *Swertia brevicornis* of Humboldt, Bonpland & Kunth, which Gilg has relegated

to synonymy, is a very short much-branched specimen, differing markedly in habit from the *S. parviflora* HBK. A close examination of the type of the former reveals the fact that the terminal branch has been broken off. Subsequent lateral offshoots give an entirely different appearance habitally. This situation is apparent also in the specimens collected by Oersted in Central America, which Gilg in 1915 labeled *H. parviflora.*

3. **H. adpressa**[49] Allen, n. sp.

Perennial, .5–2.5 dm. high; root coarse; stem usually solitary, erect, slender; basal leaves in dense rosette, oblanceolate, 1–1.5 cm. long, .3 cm. broad; cauline leaves 5–6 pairs, sessile, lanceolate, 1–1.5 cm. long, .2–.3 cm. broad, acute; inflorescence a several-flowered cyme, pedicels 2 cm. long; calyx-lobes lanceolate, .4–.6 cm. long, .15 cm. broad, obsoletely 3-nerved, midvein prominent; corolla .7–.9 cm. long, yellow, tube slightly less than one-half the length of the entire corolla; lobes ovate, auriculate, papillate, apiculate; spurs thick or slender, pendulous, more or less divergent, giving the flower a triangular appearance just preceding anthesis; stamens approximately .4 cm. long; filaments linear, anthers oval; capsule lanceolate; seeds ovoid.

Distribution: known only from Colombia.

Specimens examined:

COLOMBIA: Dept. Santander, Páramo de las Vegas, alt. 3700–3800 m., Dec. 20–21, 1926, *Killip & Smith 15679* (M TYPE, NY, US).

Species very similar to *H. brevicornis.*

4. **H. macrantha** Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 105. 1916.

Perennial herb, 5–6 cm. high, with root curved-erect, ligneous,

[49] **H. adpressa** Allen, sp. nov.—Herba perennis, usque ad 2.5 dm. alta; radice crassa; caule plerumque solitario, erecto, tenui; foliis basalibus in rosula densa, oblanceolatis, 1.–1.5 cm. longis, .3 cm. latis; foliis caulinis 5–6 geminis, sessilibus, lanceolatis, 1–1.5 cm. longis, .2–.3 cm. latis, acutis; inflorescentia multiflorifera cyma, pedicellis 2 cm. longis; calycis lobis lanceolatis, .4–.6 cm. longis, .15 cm. latis, obsolete 3-nerviis, medio-nervo prominenti; corolla .7–.9 cm. longa, flava, tubo ½ totae corollae longitudini parum subaequanti; corollae lobis ovatis, auriculatis, papillatis, apiculatis; calcaribus crassis vel tenuibus, gibbis, pendulis, plus minusve divaricatis; staminibus ca. .4 cm. longis; filamentis linearibus, antheris ovalibus; capsula lanceolata; seminibus ovoideis.—COLOMBIA: Dept. Santander, Páramo de las Vegas, alt. 3700–3800 m., Dec. 20–21, 1926, *Killip & Smith 15679* (M TYPE, NY, US).

rather elongate, covered with the blackish remains of marcescent leaves; flowering stem single, erect, internodes 4–5 cm. long, with no rosette leaves before anthesis; leaves herbaceous, acute, 3-nerved veins sunken above, prominent below; lower cauline leaves oblanceolate, gradually narrowed into a long but broad petiole, 6–7 cm. long, .5–1.5 cm. broad; upper leaves lanceolate to ovate-lanceolate, broadly sessile, about 3 cm. long; inflorescence an apical 3-flowered cyme, solitary in axils of the uppermost euphylloid leaves; pedicels of apical flowers 3 cm. long, those of laterals 2 cm.; calyx-lobes oblanceolate, 1–1.3 cm. long, 3-nerved, acute; corolla about 1.5 cm. long, green, tube about one-third the length of the entire corolla; lobes ovate to broadly ovate, very acute, somewhat apiculate; spurs large, globose, conical, calluses about .3 cm. long at the base of the tube.

Distribution: Colombia.

No specimens examined, but description compiled from original publication. (TYPE, *Kalbreyer 702*, BG).

5. **H. Karstenii** Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 105. 1916.

Biennial or perennial herb up to 5 dm. high; root branched; stems simple, covered with leaf-bases for 7–8 cm. at intervals of less than .4 cm., internodes up to 4–5 cm. long; leaves in pairs at the nodes, sessile, lanceolate, narrowed at base, 2–5.5 cm. long, up to .9 cm. broad, 3-nerved, veins excurrent, forming a mucro; inflorescence 4–12 flowers in terminal and axillary cymes, pedicels erect, up to 4 cm. long; calyx-lobes lanceolate, .6–.8 cm. long, .2–.25 cm. broad, acuminate, 3-nerved, papillate; corolla about 1 cm. long, tube not quite one-half the length of the entire corolla; lobes ovate, subrotund, erose at apex; spurs midway up the corolla tube, small, scarcely noticeable, glandular convex depressions in the corolla; stamens about .3 cm. long, at the orifice of the tube; filaments linear, anthers oval, acute; capsule 15–18 cm. long, ovate; seeds ovoid, light brown, wrinkled.

Distribution: páramos of Bogota.

Specimens examined:

COLOMBIA: Páramo de Bogota, *Karsten* (V TYPE).

6. **H. subinvolucrata** Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 99. 1916.

Perennial herb, about 2 dm. high; root multifibrous; subterranean stem vertical, short, thick, flowering stem erect, loosely leafy; leaves thickly herbaceous or somewhat fleshy, 3-nerved, veins sub-parallel, deeply sunken above, prominent below; basal leaves linear-lanceolate, gradually narrowed at the base into narrow petiole, 4–5 cm. long, .4–.5 cm. broad; lower cauline leaves similar to basal leaves; upper cauline leaves broadly sessile, lanceolate or lanceolate-ovate to ovate, 2–4 cm. long, .6–1 cm. broad; inflorescence terminal or axillary, almost sessile 3-flowered cymes, peduncles .3–.6 cm. long; floral leaves sheathing inflorescence and longer than flowers; calyx-lobes oblong-ovate, about 1 cm. long, up to .3 cm. broad, 5-nerved, minutely hirtellous, acute; corolla about 1 cm. long, tube about one-third or less the length of the entire corolla; lobes oblong-ovate, .7 cm. long, .3–.35 cm. broad, subrotund, erose at apex; spurs scarcely prominent blackish maculations at the base of the tube; stamens about .2 cm. long; anthers ovate-oblong; filaments linear.

Distribution: Venezuela.

Specimens examined:

Venezuela: high mountains of Trujillo and Mérida, alt. 1300–4900 m., 1842, *Linden 437* (DH type).

7. **H. inaequalis** Wedd. Chlor. And. **2**: 78. *pl. 53 C.* 1859; Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 99. 1916.

Herb 1.5–2(–3) dm. high; stem solitary, erect, loosely leafy, with internodes about 4–5 cm. long, and inflorescence comprising the upper third of the stem, or stem short, leafy, with internodes equidistant, 1–2 cm. long, arising in axil of every leaf; radical leaves petiolate, lanceolate to oblanceolate, 2–3 cm. long; upper cauline leaves sessile, lanceolate to elliptic, minutely hirtellous; flowers disposed in small loose pedunculate cymules; peduncles erect or slightly nodding, 1–2 cm. long; calyx-lobes lanceolate or oblong-lanceolate, acute, margin minutely hirtellous; corolla scarcely 1 cm. long, exceeding the calyx by one-fourth its length; lobes ovate, acute; spurs inconspicuous.

Distribution: known only from Venezuela.

Specimens examined:

Venezuela: Páramo de Timotes, Mérida, alt. 3800 m., Sept. 4, 1921, *Jahn 558* (HP, US); same locality, alt. 3600 m., Jan. 21, 1922, *Jahn 839* (HP, US); Mérida, alt. 3000 m., 1846, *Funck & Schlim 901* (DH type).

Funck & Schlim 1148 is cited by Weddell in the original publication of the species, but Gilg has placed this number under *H. viridis.*

8. **H. viridis** (Griseb.) Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 100. 1916.

Gentiana viridis Griseb. in Linnaea **22**: 43. 1849; Wedd. Chlor. And. **2**: 62. 1859.

H. inaequalis Wedd. Chlor. And. **2**: 78. 1859; Gilg, *l. c.*

Perennial herb, 1–3 dm. high; stem solitary, erect, thick, simple, internodes 4–5 cm. long; basal leaves in rosette, more or less coriaceous, sessile, lanceolate, subequal, up to 6 cm. long, .4 cm. broad, minutely hirtellous, 3-nerved; cauline leaves 3–4 pairs, approximately 5 cm. long; inflorescence a narrow racemiform cyme arising in the middle of the stem, with simple 3–5-flowered cymules; pedicels erect before anthesis, cernuous after, about 2.5 cm. or less long; calyx-lobes oblong-lanceolate, minutely hirtellous, about .4–.5 cm. long, nerved; corolla about 1 cm. long, greenish, tube about one-third the length of the entire corolla; lobes elliptic-lanceolate, rather obtuse, somewhat erose at apex; spurs inconspicuous; stamens .5 cm. long; anthers ovate; capsule oblong-lanceolate.

Distribution: known only from Venezuela.

Specimens examined:

VENEZUELA: Sierra Nevada, Mérida, alt. 3300 m., 1846, *Funck & Schlim 1148* (DH TYPE); Laguna Mucuy, Cabeceras del Saisay, Mérida, 4200–4300 m., April 19, 1930, *Gehriger 92a* (HP).

9. **H. Schultzei**[50] Gilg, n. sp.

Caespitose mat-like perennial, about 3 dm. high; root tough, fibrous; stems one or more, erect, simple, slender, internodes 5–7

[50] H. Schultzei Gilg, sp. nov.—Herba perennis, caespitosa, ca. 3 dm. alta; radice lenta, fibrata; caulibus 1–multis, simplicibus, tenuibus, internodiis 5–7 cm. longis; foliis basalibus in rosula densa, in petiolis longis tenuibus attenuatis, ad basin dilatatis, lineari-lanceolatis, ca. 5 cm. longis, .5 cm. latis, nerviis, acutis; foliis caulinis plerumque 2 geminis, sessilibus, linearibus, plerumque ca. 1.5 cm. longis, nerviis, acutis; inflorescentia pauco-florifera cymis terminalibus lateralibusque, pedicellis tenuibus, 1–1.5 cm. longis, ad apicem recurvatis; calycis lobis lanceolatis, ca. .6 cm. longis, acutis; corolla latissime campanulata, ca. 1.3 cm. longa, flava; corollae lobis ovatis, obtusis, marginibus erosis vel crispis; calcaribus inconspicuis.—(TYPE, *Schultze 1304*, BG).

cm. long; basal leaves in dense rosette, narrowed into long slender petioles, dilated at base, linear-lanceolate, about 5 cm. long, .5 cm. broad, nerved, acute; stem-leaves usually 2 pairs, sessile, linear, usually about 1.5 cm. long, nerved, acute; inflorescence few-flowered in terminal and lateral cymes, pedicels slender, 1–1.5 cm. long, recurved at tip; calyx-lobes lanceolate, about .6 cm. long, acute; corolla very broadly campanulate, about 1.3 cm. long, yellow; corolla-lobes ovate, rather obtuse, erose or crisped margins; spurs not discernible.

Distribution: Colombia.

No specimens examined, but description compiled from photograph. (TYPE, *Schultze 1304*, BG).

10. **H. gentianoides** Wedd. Chlor. And. **2**: 78. *pl. 53B.* 1859.

Perennial herb, up to 3 dm. high; root more or less thick, ligneous; stems sterile or flowering, long, loosely leafy; basal leaves in a dense rosette, petiolate; cauline leaves 2–6 pairs, subsessile, lanceolate, acute, 3-nerved; inflorescence lateral or terminal, small racemiform cymes, peduncles more or less resupinate; calyx-lobes oblong, up to .7 cm. long, papillate, acuminate, prominently 3-nerved; corolla about 1 cm. long, tube approximately one-third the length of the entire corolla; lobes ovate, rotund, crenulate-erose; spurs reduced to inconspicuous glandular areas not visible to the naked eye; stamens approximately .4 cm. long; filaments linear, anthers ovate, acuminate; capsule lanceolate.

Distribution: páramos of Colombia.

Specimens examined:

COLOMBIA: Páramo de Bogota, *Karsten* (V); same locality, *Goudot* (BG TYPE, M photo, V); same locality, *Triana 1964* (DH, V); same locality, Jan. 17, 1854, *Holton 467* (DH, G); Guasca, 1919, *Ariste-Joseph A423* (US).

11. **H. stellarioides** Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 100. 1916.

Perennial? herb, up to 3 dm. high; flowering stem erect, loosely leafy, internodes 4–7 cm. long; basal leaves lacking; cauline leaves sessile, lanceolate to linear-lanceolate, 2.5–3.5 cm. long, gradually decreasing toward the summit, .4–.5 cm. broad, acute, 3-nerved; inflorescence lateral or terminal, 5–7-flowered cymes, pedicels more or less erect, up to 1.5 cm. long; calyx-lobes lance-

olate or oblong-lanceolate, about .8 cm. long, .25 cm. broad, acute, 3-nerved, or nerves obsolete; corolla about 1 cm. long, tube about one-third the length of the entire corolla; lobes ovate-oblong, upper margin subcrenulate, acute; spurs semi-globose callous prominences at the base of the tube.

Distribution: páramos of Colombia.

No specimens examined, but description compiled from original publication and photograph. (TYPE, *Lehmann 8080*, BG).

12. **H. verticillata** Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 103. 1916.

Annual herb, slender, up to 1 m. high; root fibrous; stem .5 cm. thick, becoming black, covered with the remains of early leaves, densely leafy at the middle or just below the middle of the stem, internodes up to 8 cm. long; basal leaves in dense whorls for a varying distance up the stem, connate, sessile, linear-lanceolate, 10 cm. or less long, .8 cm. broad, acuminate, 5-nerved, fleshy; cauline leaves in 7–8 whorls of 3, lanceolate (extreme upper subtending inflorescence, ovate-lanceolate), 5-nerved, 5–6 cm. long, gradually decreasing in length toward the summit, with corresponding increase in width; flowers numerous, disposed in 3–5 verticillate, axillary and terminal cymose clusters; pedicels erect, up to 3.5 cm. long; calyx-lobes oblong-lanceolate, papillate on under surface of veins and entire upper tip, up to 1.0 cm. long, .2–.35 cm. broad, acuminate to acute, 5-nerved, veins parallel, becoming confluent at tip; corolla apple-green or yellowish-green, up to 1.7 cm. long, tube about one-third the length of the entire corolla; lobes broadly ovate, subrotund, erose and papillate at tip; spurs subglobose glandular prominences at the base of the corolla.

Distribution: wet páramos about volcanos, Colombia.

Specimens examined:

COLOMBIA: "Cauca am Vulkan," Sotará, 3500 m., *Lehmann 6190* (BG TYPE, F); Dept. of El Cauca, Mt. Pan de Azucar, alt. 3500–3700 m., June 16, 1922, *Pennell 7052* (ANSP, G, NY, S, US).

13. **H. foliosa** Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 101. 1916.

Biennial herb (?), up to 8 dm. high; root stout (?); flowering stems 1–many, erect, simple, few or no leaves at base, lower internodes 1–1.5 cm. long, upper 5–7 cm. long; numerous pairs

of lower cauline leaves, thickly herbaceous, gradually narrowed toward the base but dilated again at base, lanceolate, 3–5 cm. long, about 1 cm. broad, acute, 3–5 nerved; upper cauline leaves herbaceous, gradually narrowed toward the base and broadly sessile, ovate-elliptic, 3–5 cm. long, about 1 cm. broad, acute to very acute, 5-nerved, veins parallel, sunken above, prominent below; terminal and axillary, loosely arranged, many-flowered elongate cymes, comprising a thyrsoid inflorescence 10 cm. long, pedicels about 2.5 cm. long; small upper leaves shorter than the inflorescence; calyx-lobes ovate-oblong, .7–.8 cm. long, .3 cm. broad, acute or very acute, 3-nerved; corolla about 1.3 cm. long, tube about one-fourth the length of the entire corolla; spurs semi-globose protuberances at the base of the tube.

Distribution: páramos of Colómbia.

Specimens examined:

Colombia: Dept. of Bolivar-Antioquia, Páramo de Chaquiro, alt. 3000–3200 m., Feb. 23, 1918, *Pennell 4268* (NY, US). (type not seen, *Stübel 276*, BG, M photo).

14. **H. dasyantha** Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 103. 1916.

Perennial herb, (1.5–)3–7 dm. high; root thick; stem erect, simple, more than .5 cm. thick, fleshy, brown in dried specimens, faintly striate, covered with remains of marcescent leaves, 2–5 internodes up to 10 cm. long; basal leaves in a dense rosette, broadly elliptic, up to 10 cm. long, nearly 2 cm. broad, acute, 5-nerved; 3–5 pairs of cauline leaves, sessile, dilated at base, oblong-lanceolate, 4–10 cm. long, their length gradually decreasing toward the summit, 1–2 cm. broad, acute, 5-nerved; inflorescence axillary and terminal, many-flowered racemose cymes, usually 10 cm. long; pedicels erect, for most part up to 3.5 cm. long; calyx-lobes ovate to ovate-lanceolate, papillate, up to 1 cm. long, .4–.5 cm. broad, acute to abruptly acuminate, 3-nerved; squamellae frequently scale-like lobed bodies; corolla 1.5–2 cm. long, pale greenish-yellow, tube nearly equal in length to the entire corolla; lobes ovate, subrotund, erose at apex, somewhat papillate; spurs small subglobose prominences at the base of the corolla-lobes, almost obscured by the calyx; stamens approximately .4 cm. long, attached at the summit of the tube; filaments linear, anthers ovate-oval; stigma reflexed; capsule up to 2 cm. long; seeds elliptical, reticulate.

Distribution: moist grassy páramos, or dry open woods, Colombia.
Specimens examined:
COLOMBIA: Dept. of Caldas, Páramo del Quindio, alt. 3700–4200 m., Aug. 15–20, 1922, *Pennell & Hazen 9997* (ANSP, NY, US); Dept. of Tolima, Páramo de Ruiz, alt. 3500–3800 m., Dec. 16–17, 1917, *Pennell 3001* (NY, M, US); Dept. of Cauca, Páramo de Buena Vista, Huila group, Central Cordillera, alt. 3000–3600 m., Jan. 1906, *Pittier 1111* (US). (TYPE not seen, *Lehmann 2065*, BG, M photo.).

This species is very similar to *H. elata* but is, on the whole, a larger and coarser plant. Since the material is scanty and the geographical location different, *H. dasyantha* has for the present been maintained as a distinct species.

15. **H. elata** Wedd. Chlor. And. **2**: 78. 1859.

Perennial, up to 5 dm. high; stem thick, coarse, erect, loosely leafy; numerous basal leaves in dense rosette, broadly lanceolate, attenuate into petiole, dilated at base, 7–10 cm. long, approximately 1 cm. broad, 5-nerved, acuminate; cauline leaves more or less sessile, shorter, lanceolate, acute; inflorescence numerous loose terminal and lateral cymes, peduncles up to 3 cm. long; calyx-lobes oblong-lanceolate to ovate-lanceolate, .7–.8 cm. long, 3-nerved, papillate, acute; corolla hardly one-fourth more than the length of the calyx, tube slightly more than one-half the length of the entire corolla; lobes ovate, obtuse; spurs inconspicuous tubercules at the extreme base of the corolla; stamens .6 cm. long; anthers narrowly ovate, filaments linear.

Distribution: in the Sierra Nevada of Santa Marta, Venezuela.
Specimens examined:
VENEZUELA: Sierra Nevada de Santa Marta, Caracas, 1844, *Funck 415* (DH TYPE).

16. **H. Tolimae** Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 101. 1916.

Perennial herb, 2.5–3 dm. high; root thick; root-stalk thick, densely covered with remains of marcescent leaves; one to few flowering stems, thick, erect, simple for the most part, very narrowly winged, internodes 3–6 cm. long; basal leaves arranged in rosette, slightly narrowed into long broad petioles, dilated at the base, lanceolate, 5–8 cm. long, up to .5–.6 cm. broad, 3–5-nerved, acute; stem-leaves 2–3 at a node, sessile, broadly lanceolate, 4–6 cm. long, .6–.7 cm. broad, their size gradually decreasing toward the summit, 3–5 subparallel veins, sunken above,

prominent below, reticulate; inflorescence few-flowered (5–7) cymes, axillary and terminal; pedicels more or less resupinate, up to 3 cm. long, the central one longer; calyx-lobes ovate to ovate-oblong, papillate, .7–.9 cm. long, .25–.35 cm. broad, subacuminate, 3-nerved; corolla up to 1.3 cm. long, light greenish-yellow, tube slightly less than one-third the length of the entire corolla; lobes ovate, erose and papillate at the tip; spurs glandular subglobose protuberances at the base of the tube, obscured by the calyx; stamens approximately .4 cm. long; filaments linear, anthers ovate; capsule lanceolate, apiculate, 2 cm. long; seed ovoid-elliptical, very minutely reticulate, pale tan.

Distribution: grassy páramos of Colombia.

Specimens examined:

Colombia: Dept. of Caldas, Páramo del Quindio, alt. 4100–4400 m., Aug. 15–20, 1922, *Pennell & Hazen 9841* (ANSP, G, NY, US); (type not seen, *Stubel 228*, BG, M photo.); bare loam slopes below snow, same locality and date, alt. 4300–4500 m., *Pennell & Hazen 9894* (ANSP, NY, S, US).

This last-cited specimen has leaves broader than those of the type, but is similar otherwise. *H. Tolimae* appears to be closely related to *H. elata*.

17. **H. hygrophila** Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 102. 1916.

Biennial herb, about 6 dm. high; root ligneous; subterranean root-stalk covered with darkened leaf-bases; flowering stem fleshy, erect, simple, 1 cm. thick, faintly winged, internodes up to 8 cm. long; 30–40 basal leaves in a dense rosette, linear, up to 12 cm. long, .5–.9 cm. broad, acute, 5-nerved; cauline leaves yellow-green, 3–4 pairs, the lower lanceolate, the upper subtending the inflorescences, ovate-lanceolate, sessile, 5–7 cm. long, gradually decreasing in size toward the summit, approximately .8–1.2 cm. broad, 7-nerved, parallel veins confluent at tip; inflorescence terminal and axillary in upper stem-leaves, in dense many-flowered cymes, giving spicate appearance, pedicels erect, up to 3 cm. long; calyx-lobes ovate-oblong to ovate, papillate, .9–1.0 cm. long, narrowly acute, 5-nerved, reticulate; corolla up to 1.5 cm. long, yellowish-green, tube approximately one-third the length of the entire corolla; lobes ovate, erose at apex; spurs angular sac-like prominences at the extreme base of the corolla lobes, obscured by calyx; stamens approximately .7 cm. long, attached at the orifice of the tube; filaments linear,

anthers broadly oblong, apiculate; capsule lanceolate; seeds elliptic, pale tan, reticulate.

Distribution: páramos of Andes, Colombia.

Specimens examined:

COLOMBIA: Páramo of Guanacas, Central Andes of Popayan, 3000–3600 m., *Lehmann 7860* (F, G, BG TYPE, M photo, US).

18. H. parallela[51] Allen, n. sp.

Perennial herb, up to 6 dm. high; root-stalk thick; flowering stem single, erect, simple, or branched above, striate, lower internodes 1–1.5 cm. long, upper 4–6 cm. long; numerous basal leaves in rosette, almost sheathing, lanceolate, 3–5-nerved, about 9 cm. long, 1 cm. broad; cauline leaves about twelve pairs, more remote toward the apex, sessile, lanceolate to elliptic, 4–6 cm. long, gradually decreasing toward the summit, approximately 1 cm. broad, 3–5 subparallel veins sunken above, prominent below; inflorescence 1 or more many-flowered axillary and terminal cymes, pedicels more or less erect, up to 3.5 cm. long, the lateral somewhat shorter than the terminal; calyx-lobes ovate, papillate, .7–.9 cm. long, .4 cm. broad, attenuately acute, prominently 5–7-nerved, veins subparallel; corolla about 1.3 cm. long, probably greenish?, tube about one-fourth the length of the entire corolla; lobes broadly ovate, slightly papillate, crisped toward the tip, abruptly acuminate; spurs large globose protuberances at the base of the tube, obscured by calyx; stamens nearly .5 cm. long, attached at the orifice of the tube; filaments linear, anthers oblong; capsule lanceolate.

[51] **H. parallela** Allen, sp. nov.—Herba perennis, usque ad 6 dm. alta; radice crassa; caule florifero solitario, erecto, simplice vel supra ramoso, striato; internodiis inferioribus 1–1.5 cm. longis, superioribus 4–6 cm. longis; foliis basalibus multis, in rosula densa, fere vaginantibus, lanceolatis, 3–5-nerviis, ca. 9 cm. longis, 1 cm. latis; foliis caulinis ca. duodecem geminis, ad apicem remotioribus, sessilibus, lanceolatis vel ellipticis, 4–6 cm. longis, sensim sursum decrescentibus, ca. 1 cm. latis, 3–5-nerviis, nervis subparallelis, supra immersis, infra prominentibus; inflorescentia cymis 1- vel pluro-floriferis axillaribus et terminalibus; pedicellis plus minusve erectis, usque ad 3.5 cm. longis, lateralibus terminalibus brevioribus; calycis lobis ovatis, papillatis, .7–.9 cm. longis, .4 cm. latis, attenuate acutis, prominente 5–7-nerviis, nervis subparallelis; corolla ca. 1.3 cm. longa, forte viridula, tubo ca. ¼ totae corollae longitudini adaequanti; lobis late ovatis, parum papillatis, ad apicem crispis abrupte acuminatis; calcaribus magnis globosis gibbis ad basin tubi calyce obscuratis; staminibus ca. .5 cm. longis, tubi summo adjunctis; filamentis linearibus, antheris oblongis; capsula lanceolata.—VENEZUELA: Páramo de La Negra, Mérida, Dec. 1927, *Gutzwiller 32* (HP TYPE, US).

Distribution: Venezuela.
Specimens examined:
VENEZUELA: Páramo de La Negra, Mérida, Dec. 1927, *Gutzwiller 32* (HP TYPE, US).

Species near *H. foliosa* and *H. hygrophila*.

19. **H. major** Wedd. Chlor. And. 2: 79. 1859.

Annual probably, up to 6 (?) dm. high; (root not seen); stem erect, simple below, branched above, loosely leafy, very narrowly winged and striate; leaves sessile, subconnate, broadly elliptic, 2–7 cm. long, .5–2 cm. broad, somewhat abruptly acuminate, 3–5-nerved; inflorescence terminal and axillary 3–6-flowered subumbelliform cymes, pedicels 4 cm. long, usually erect, frequently nodding at apex; calyx-lobes oblanceolate to subspatulate, up to .8 cm. long, .25 cm. wide, 3-nerved, midvein very prominent; corolla 1.0–1.3 cm. long, tube almost one-half the length of the corolla; lobes ovate, erose at apex; spurs small upcurved conical protrusions almost at the orifice of the tube; stamens approximately .5 cm. long, at the orifice of the tube; filaments linear; anthers not seen; capsule ovate, 1.3–1.6 cm. long; seeds oval, brown-black, wrinkled.

Distribution: shrub zone, mountain bases, Colombia.
Specimens examined:
COLOMBIA: Dept. of El Cauca, Mt. Pan de Azucar, alt. 3300–3600 m., June 16, 1922, *Pennell 7034* (ANSP, NY, US); Dept. of Cundinamarca, Sibate, alt. 2700–2800 m., Oct. 13–15, 1917, *Pennell 2438* (M, US); Dept. of Caldas, Cerro Tatama, alt. 3400–3700 m., Sept. 8–10, 1922, *Pennell 10575* (US). (TYPE not seen, *Goudot*, HJP).

SECTION 2. HALENIASTRUM

KEY TO NORTH AMERICAN SPECIES AND VARIETIES

1. Spurs spreading to ascending.
  2. Plant less than 2.5 dm. high.
    3. Biennial; flowers white; distribution Mexico............ *20. H. crassiuscula*
    3. Annual; flowers purple; distribution Canada *23a. H. deflexa* var. *Brentoniana*
  2. Plant more than 2.5 dm. high.
    3. Spurs, if present, about ½ the length of the corolla......... *21. H. Pringlei*
    3. Spurs less than ½ the length of the corolla.
      4. Annuals; leaves mostly cauline.
        5. Stem-leaves linear.................................... *22. H. recurva*
        5. Stem-leaves lanceolate to ovate....................... *23. H. deflexa*
      4. Perennials; leaves mostly radical.
        5. Strict, many-flowered, spike-like inflorescence.
          6. Stem erect................................ *24. H. rhyacophila*
          6. Stem procumbent............. *24a. H. rhyacophila* var. *procumbens*

5. Loose, broad, few-flowered inflorescence...*24b. H. rhyacophila* var. *macropoda*
1. Spurs pendulous to incurved.
2. Leaves not apiculate or very rarely so; calyx-segments not mucronulate.
3. Basal rosette absent; leaves mostly cauline.
4. Habit erect; leaves less than 3 cm. long.
5. Leaves linear....................................*25. H. Palmeri*
5. Leaves lanceolate or ovate.
6. Calyx-lobes mostly obtuse, appressed...........*26. H. Conzattii*
6. Calyx-lobes acute, reflexed.....................*27. H. Schiedeana*
4. Habit prostrate; leaves 5–12 cm. long..................*28. H. caleoides*
3. Basal leaves present, cauline few or none.
4. Spurs incurved, ½ or less than ½ the length of the corolla.
5. Sterile branches present; leaves numerous..........*29. H. platyphylla*
5. Sterile branches absent; leaves less than 15.
6. Flowers 1.5 cm. or less long.
7. Flowers less than 1 cm. long; spurs rudimentary..*30. H. nudicaulis*
7. Flowers more than 1 cm. long; spurs ⅛–½ the length of the corolla..................................*31. H. plantaginea*
6. Flowers more than 1.5 cm. long...*31a. H. plantaginea* f. *grandiflora*
4. Spurs spreading, about ½ the length of the corolla.
5. Stems always erect.
6. Leaves linear....................................*32. H. Shannonii*
6. Leaves elliptical..................*32a. H. Shannonii* f. *compacta*
5. Stems more or less decumbent....................*33. H. decumbens*
2. Leaves conspicuously apiculate; calyx-segments mucronulate.
3. Plant more than 2 dm. high.........................*34. H. guatemalensis*
3. Plant less than 2 dm. high...........*34a. H. guatemalensis* var. *latifolia*

20. H. crassiuscula Robinson & Seaton in Proc. Am. Acad. **28:** 113. 1893.

Small caespitose biennial of dense habit, slightly fleshy; stems erect, 0.4–1.0 dm. high, narrowly winged, much branched; radical leaves broadly oblanceolate to elliptic, 2 cm. long, obtuse, attenuate into long petiole nearly equalling the blade, 3-nerved; cauline leaves 1–3 pairs, narrowly oblanceolate to oblong, narrowed at the base; inflorescence dense compact umbellate cyme; flowers terminal or axillary, pedicellate, after anthesis slightly nodding, not at all resupinate; calyx-segments lanceolate to oblanceolate, .45–.6 cm. long, obtuse, papillate, 3-nerved; corolla white, up to 1.5 cm. long, about .5 cm. broad at base, tube .35–.4 cm. long; lobes oblong-elliptic, acute; spurs .4 cm. long, arising slightly below the midpoint of the tube, slender, spreading, and curved upwards; stamens .25 cm. long, anthers ovate; filaments linear; capsule lanceolate, frequently subfalcate, acute, 1.4 cm. long; seeds globose, light yellow-brown, granular.

Distribution: bare alpine summits, Mexico.
Specimens examined:
MEXICO: Nevado de Toluca, bare alpine summits, alt. 3500 m., Sept. 2, 1892, *Pringle 4229* (ANSP, BG, BM, B, CAS, C, DH, F, G TYPE, IAC, K, M, NY, S, US, V); Ixtaccihuatl, wet meadows, alt. 3000–3250 m., March–July 1903, *Purpus 318* (CAS, M, US); Popocatepetl, Aug. 7–8, 1901, *Rose & Hay 5999* (US).

21. **H. Pringlei** Robinson & Seaton in Proc. Am. Acad. **28:** 113. 1893.

Halenia candida Ramirez in Inform. Secret. Foment. Mexico (Excurs. Mont. Ajusco), 34. 1895; Estud. Hist. Nat. 102. 1904.

Biennial, of glaucous aspect; root thick, tough, ligneous; stem usually solitary, occasionally caespitose, simple or nearly so, scape-like, slender, erect, 1–2.5 dm. high; leaves less than 3 cm. long, radical leaves elliptic to narrowly oblanceolate, faintly 3-nerved, attenuate below into slender petioles, usually as long as the leaf-blade and persistent; cauline leaves 1–2 pairs, sessile, short, sublinear, 1.5–3 cm. long, about .3 cm. broad; flowers disposed in terminal, or occasionally lateral, few-flowered umbelliform cymes, pedicels less than 2 cm. long, usually about .8 cm.; calyx-lobes oblong-spatulate, .3–.5 cm. long, acuminate, 3-nerved; corolla white, .8–1.5 cm. long, spurless in the majority of cases; when spurs present, slender, spreading, and curved-ascending, 1.5–1.8 cm. from tip to tip, with prominent veins and glandular tips; corolla-tube up to .2 cm. long; corolla-lobes elliptic, acuminate; stamens .2–.35 cm. long; anthers narrowly ovate, minutely papillate, filaments linear, slightly uncinate; capsule lanceolate, acute, exserted; seeds subglobose, yellow-brown, granular.

Distribution: springy meadows of central and south Mexico.
Specimens examined:
MEXICO: springy alpine meadows, Sierra de las Cruces, alt. 2450 m., Aug. 28, 1904, *Pringle 13121* (BG, C, UC, G, K, US); same locality, Aug. 23, 1892, *Pringle 4209* (ANSP, C, CAS, DH, F, G TYPE, IAC, K, M, NY, S, US, V); same locality, June 1895, *Altamirano 908* (US).
SOUTH MEXICO: without locality, 1920–21, *Reiche 36* (BG).

The habit of this species is very similar to that of *H. nudicaulis.* The Pringle specimens cited above were collected in August, and the plants are smaller and grow less luxuriantly than the single specimen collected in June by Altamirano. The specimens collected later in the season very rarely possess spurs, while the

earlier plants show a distinctly spurred corolla. This condition is shown in other species to a somewhat less extent, and is in all probability traceable to variation in environmental conditions.

22. **H. recurva** (Sm.) Allen, n. comb.

Swertia recurva Smith in Rees, Cyclopedia **34**: sub *Swertia*. 1819.

Halenia Rothrockii Gray in Proc. Am. Acad. **11**: 84. 1876; Rothrock, Rept. Wheeler Exped. 195, *pl. 21*. 1878; Hemsl. Biol. Cent.-Am. Bot. **2**: 353. 1882.

Tetragonanthus Rothrockii Heller, Cat. N. Am. Pl. 6. 1898, and ed. 2, 16. 1900.

Annual, 2.5–5 dm. high; stem simple, often branched above; basal leaves less than 3.5 cm. long, .6 cm. broad, elliptic-lanceolate to spatulate; cauline leaves remote, lance-linear, 1.5–4 cm. long, about .35 cm. broad, obscurely 3-nerved, midrib prominent below; inflorescence a loosely flowered subumbellate cyme; flowers on slender pedicels, .5–3 cm. long, often in sevens; calyx lobes lanceolate, elongate-acute, up to .6 cm. long, uninerviate, papillate; corolla bright-yellow, about 1–1.2 cm. long, tube less than one-half the length of the entire corolla; corolla-lobes ovate, subacuminate, delicately veined, papillate; spurs curved, horizontal or ascending, up to 1.6 cm. from tip to tip; anthers broadly oblong, mucronate, papillate; filaments slightly obovate; capsule ovate-lanceolate; seeds yellow-brown, subglobose-ovoid, granular.

Distribution: southern United States and Mexico.

Specimens examined:

UNITED STATES:

ARIZONA: Mt. Graham, alt. 2250 m., Sept. 1874, *Rothrock 733* (ANSP, F, IAC, M, US); same locality, Aug. 1874, *Rothrock* (G, NY); Chiricahua Mts., Sept. 22. 1931, *Jones 28603* (M); Barfoot Park, Chiricahua Mts., alt. 2000–2050 m., rolling andesitic, recently lumbered pine land, Sept. 8, 1906, *Blumer 1359* (BG, D, G, K, M, NY, US, V); same locality, alt. 2480 m., Sept. 22–23, 1914, *Eggleston 10774* (US); Apache Pass, Chiricahua Mts., Sept. 1881, *Lemmon & Lemmon* (CAS); Hermitage, Chiricahua Mts., Sept. 1881, *Lemmon & Lemmon* (CAS); Rucker Valley, Chiricahua Mts., Sept. 1881, *collector unknown 1874* (CAS, DH, F, SM); White Mts., Aug. 1873, *Lour* (F); summit of White Mts. (Springerville-Fort Apache Road), Apache Reservation, alt. 2270–2880 m., Aug. 29, 1919, *Eggleston 15781* (F); Riverside Ranger Station, Greer, Apache Forest, alt. 2700 m., Aug. 24, 1920, *Eggleston 17137* (NY, US); grassy flats near Brinkley's Ranch, White Mts., Aug. 5, 1915, *Ellis 20* (US); Riggs Flat, Pinaleno Mts., alt. 2000 m., Sept. 23, 1917, *Shreve 5373* (G); Columbia Trail, Pinaleno Mts., alt. 2500 m., Sept. 13, 1914, *Shreve 4312* (CAS, US).

New Mexico: Mogollon Mts., on or near the west fork of the Gila River, Socorro Co., alt. 2125 m., Aug. 14, 1903, *Metcalfe 501* (M, NY); swampy ground, divide of Mogollon Mts., Sept. 7, 1881, *Rusby 264* (ANSP, BM, CAS, F, K, M, NY, US); same locality, Aug. 1881, *Rusby* (IAC, NY).

Mexico:

Chihuahua: Mt. Mohinora, Sept. 1, 1898, *Nelson 4868* (G, US); cool slopes, Sierra Madre, alt. 1750–2375 m., Sept. 27, 1888, *Pringle 1663* (BG, BM, B, CAS, DH, M, NY, S, V); same locality, Sept. 24, 1887, *Pringle 1329* (ANSP, BG, C, G, K, NY, US); Meadow Valley, Sierra Madre Mts., alt. 1750 m., Sept. 17, 1903, *Jones* (S); Sierra Madres, near Colonia Garcia, alt. 2000 m., Sept. 6, 1899, *Townsend & Barber 309* (BB, F, DH, G, M, NY, US); Escalon, *Mutis* (L).

Coahuila: Sierra Madre, 40 m. south of Saltillo, July 1880, *Palmer 839* (ANSP, G, K, US).

Durango: Barranca, below Sandia Station, alt. 1625 m., Oct. 13, 1905, *Pringle 13588* (G, S, UC, US); Sierra de Candela, alt. 3000 m., Aug. 27, 1903, *Endlich 53* (BG).

Jalisco: Sierra de Tequila, alt. 2000 m., July 5, 1893, *Pringle 5465* (G).

The name *Swertia recurva* Smith was given to the specimen collected by Mutis and sent to Linnaeus, now preserved in the herbarium of the Linnaean Society of London. The description published in Rees' 'Cyclopedia' was inadequate, and later the specific name *recurva* was placed under *deflexa*, the well-known northern species. Since few of the succeeding monographers ever saw the original *Swertia recurva* Sm., it is not strange that the error persisted. Over fifty years later, Gray described *Halenia Rothrockii* as a new species. A careful examination of both specimens reveals the fact that they are identical, in which event the correct specific name is *recurva*.

23. **H. deflexa** (Sm.) Griseb. Gen. & Sp. Gent. 324. 1839; Hook. Fl. Bor.-Am. **2**: 67. *pl. 155.* 1840; Dietrich, Syn. Pl. 2: 918. 1840; Torr. Nat. Hist. N. Y. **2**^{2}: 110. 1843; Robinson in Gray, Man. ed. 7, 659. 1908; Johnson, Tax. Fl. Pl. 488. *fig. 340.* 1931; Louis-Marie, Fl. Man. Prov. Queb. 214, *pl. 68, fig. 11.* 1931.

Swertia deflexa Smith in Rees, Cycl. **34**: sub *Swertia.* 1819.

S. corniculata Michx. Fl. Bor.-Am. **1**: 97. 1803.

S. americana Spreng. Syst. **1**: 661. 1825.

S. Michauxiana G. Don, Gen. Hist. **4**: 177. 1838; Schl. & Cham. in Linnaea **5**: 122. 1830.

Halenia Michauxiana G. Don, Gen. Hist. **4**: 177. 1838.

H. heterantha Griseb. Gen. & Sp. Gent. 325. 1839.

H. reflexa Griseb. in DC. Prodr. **9**: 135. 1845, sphalm.

Tetragonanthus deflexus Kuntze, Rev. Gen. Pl. **2**: 431. 1891; Heller, Cat. N. Am. Pl. 6. 1898, and ed. 2, 161. 1900; Britt. Man. 734. 1901; Britt. & Brown, Ill. Fl. **3**: 15, *fig. 3365*. 1913; Small, Fl. Southeastern U. S. 931. 1913.

T. heteranthus Heller, Muhlenbergia **1**: 2. 1900.

T. heterantherus Heller, Cat. N. Am. Pl. ed. 2, 161. 1900, sphalm.

T. deflexus heteranthus Britt. Man. 735. 1901.

Annual, 1–9 dm. high; stem simple or branched above, quadrangular; leaves 3–5-nerved, basal oblong-spatulate, 1–2 cm. long, petiolate; cauline leaves oblong-lanceolate to ovate, acuminate, 1–5 cm. long, .5–2 cm. broad; internodes 6–8 cm. long; flowers disposed in a terminal or axillary, loose umbelliform verticillate cyme; calyx .4–.8 cm. long, segments ovate-lanceolate, acuminate, papillate; corolla purple, .8–1.4 cm. long, lobes lanceolate to ovate, acute, papillate, tube about equalling the limb; spurs .3–.5 cm. long, slender, cylindrical, obtuse, curved-spreading, deflexed at apex, glandular, frequently lacking in lower flowers or in flowers blooming late in the season; stamens slightly uncinate; anthers ovate, filaments linear; capsule lanceolate; seeds oblong-ovoid, greenish-brown, granular.

Distribution: cool damp woods, from Labrador to New York, west to British Columbia and Montana; also in central Mexico.

Specimens examined:

(?) Labrador: Caribou Island, 1870, *Macfarlane* (BB); same locality, *Martin* (G); without locality, *Rothrock* (F).

Newfoundland: calcareous rocks and talus, entrance to Port Saunders Harbor, Ingornachoix Bay, Aug. 1, 1910, *Fernald, Wiegand & Kittredge 3911* (G); Chimney Cove, Aug. 16, 1896, *Waghorne* (DH, G, M); without locality, *Banks* (G); *Brenton* (K).

Nova Scotia: hills between northeast Margaree and Grand Etang, Cape Breton, Aug. 13, 1906, *Robinson 384* (NY).

New Brunswick: Fredericton, Aug. 1881, *Bailey* (US); Drury's Cove, St. Johns, Aug. 18, 1873, *Boott* (G); Falls, Aroostook River, Aug. 17, 1901, *Churchill* (M); Charlo, Restigouche, July 30, 1894, *Fowler* (US); Sugar Loaf, Restigouche, Bass River, Aug. 3, 4, 1873, *Fowler* (M); same locality and collector, Aug. 1, 1882 (F); St. Johns, July 12, 1877, *Fowler* (ANSP); Eel River, York Co., July 20, 1882, *Hay* (ANSP); open woods, Connors, July 20, 1908, *Mackenzie 3618* (M, NY, US); dry fields, Rothesay, St. Johns, *Mathew* (BG); Saint Francis Parish, July 29, 1900, *Williams* (CAS, G).

Quebec: St. Anne des Monts, Gaspé Co., Aug. 16, 1881, *Allen* (NY); wet woods, Rivière du Loup, *Canby* (F); woods, Lake Memphremagog, July 22, 1902, *Churchill* (G); wet woods about Georgeville, Lake Memphremagog, Aug. 1, 2, 20, 1914,

Churchill (F, G, K, M, NY, US); Carleton, Bonaventure Co., July 23, 24, 27, 1904, *Collins, Fernald & Pease 4261* (G); cool wooded banks, between Baldé and the Baie des Chaleurs, Bonaventure River, Bonaventure Co., Aug. 5, 6, 8, 1904, *Collins, Fernald & Pease* (G); Rivière du Loup, Aug. 1902, *Eggleston 3051* (DH, K, M, NY, S, US); St. Anne des Monts, July 15, 1923, *Eames* (SM); slaty soil, Rimouski, July 18, 1907, *Fernald 1151* (G); alluvial wooded banks, Rivière Ste. Anne des Monts, Gaspé Co., July 16, 1906, *Fernald & Collins 244* (K, NY, UC, US); wood-road along Rivière Cap Chat, Matane Co., Aug. 18, 1923, *Fernald, Dodge & Smith 25986* (G); Matane, near the St. Lawrence, Gaspé, Aug. 6, 1904, *Forbes* (G); Little Metis, Aug. 7, 1906, *Fowler* (G); Anticosti, Aug. 1, 1861, *Hyatt, Shaler & Verrill* (G); Rivière du Loup, Aug. 15, 1892, *Kennedy* (ANSP, G); Mt. Albert, Gaspé, Aug. 1882, *Macoun* (NY); wet rocks, Salt Lake, Anticosti, Aug. 11, 1883, *Macoun* (BM); Anse à Persil, Rivière du Loup, July 1913, *Marie-Victorin 28* (G, NY, SM, US); Baie Girard (Lake Temiscaming), Abitibi, June 27, 1918, *Marie-Victorin 8349* (US); "Lac Sale: dans la prairie naturelle près de la maison du garde," Anticosti, July 23, 1927, *Marie-Victorin & Rolland-Germain 27159* (G); "Rivière Vaureal: talus calcaires," Anticosti, July 31, 1925, *Marie-Victorin, Rolland-Germain & Louis-Marie 21076* (G); "Le long de la Rivière Sainte Anne des Monts; á 10 milles de l'embouchure, Gaspésie," Aug. 3, 1923, *Marie-Victorin, Brunel, Rolland-Germain & Rousseau 17663* (G); Notre Dame de Lac, Temiscouata Co., July 9, 1903, *Moore 1211* (G); same locality, July 30, 1887, *Northrup 69* (NY); Georgeville, July 28, 1902, *Pease 1081* (G); abundant along shores of Lake Memphremagog, Georgeville, July 31, 1902, *Pease 1082* (G); Notre Dame du Lac, Temiscouata Co., July 9, 1903, *Pease 2384* (G); Georgeville, July 31, 1902, *Pease 2910* (G); Rivière du Loup, St. Lawrence, 1860, *Pickering* (G); Lower St. Lawrence, Aug. 6, 1879, *Pringle* (US); shore of St. Lawrence, Temiscouata, Aug. 7, 1879, *Pringle* (F, G, IAC, M, US); banks of Grand River, Gaspé Co., June 20–July 10, 1903, *Richards* (G); "Cap à l'original: clairière; dans un bois de conifères, Comté de Rimouski, Bic," July 19, 1927, *Rousseau 30711* (G, M); "Cap aux Corbeaux: dans un bois de conifères; sur le conglomérat. Bic, Comté de Rimouski," July 14, 1927, *Rousseau 26646* (M); "Ile Bayfield (Sandy Island), Archipel de St. Augustin," Labrador Peninsula, Saguenay Co., July 21, 1915, *St. John 90688* (G); roadside, Lac du Saumon, Matane Co., Aug. 15, 1923, *Svensen & Fassett 2096* (G, SM); Anticosti, *Verrill* (F); damp grassy open meadow, Pointe Nouvelle, Hope Township, Bonaventure Co., July 30, 1902, *Williams & Fernald* (G); Bic, July 16, 1910, *Williamson 1422* (ANSP, NY).

Ontario: banks of the Maitland River, 1836 *Goderiels* (DH); Moose Factory, Hudson's Bay, July 1, 1881, *Haydon* (K); same locality, 1880, *Haydon* (K); between Moose Factory and Rupert's House, southern end of Hudson's Bay, June 12, 1860, *Drexter* (G); Sand River, Aug. 24, 1928, *Heinburger* (COP); Pic River, Lake Superior, *Loring* (G); Lake Huron, Aug. 3, 1871, *Macoun 2239* (DH); Whitefish Island, Lake Huron, Aug. 28, 1901, *Macoun 300* (NY); "Lake Region and Ontario," July 29, 1874, *Macoun 1191* (K); damp woods, Lake Niphigon, July 10, 1884, *Macoun* (BM); Salt, July 29, 1891, *Morton* (D); damp soil, Gray (mile 229 of Algoma Central Ry.), June 23, 1921, *Pease 18030* (G); shaded bank, Burnt Rock Pool, Agawa R., June 21, 1921, *Pease 18058* (G); moss-grown fissures of Laurentian rocks along Onaman River, Thunder Bay District, 1912, *Pulling* (G); Minaki, July 25, 1915, *Thompson 31* (M); swamp, New Hanbury, Aug. 14, 1899, *Umbach* (BG, US); vicinity of Fort William, dry banks, Aug. 5, 1912, *Williamson 2090* (ANSP); same locality, July 15, 1869, *Macoun* (K).

MAINE: Penobscot River, 1836, *Bailey* (NY); Katahdin, woods near Mountain, *Blake* (C, F); swamp woods, *Chute* (F); gravelly thicket, Boundary Lake, St. Francis River Valley, Aroostook Co., Aug. 12, 1902, *Eggleston & Fernald* (G); Brookline (Naskeag Point), *Faxon* (G); open woods, Fort Kent, Aug. 4, 1907, *Fellows* (US); moist banks, Aroostook Co., Aug. 25, 1893, *Fernald* (DH); wooded gravelly river-bank, Island Falls, valley of Mattawamkeag, Aroostook Co., Sept. 6, 1897, *Fernald* (G); wooded river-bank, Van Buren, Aroostook Co., Sept. 18, 1900, *Fernald* (G); damp, wooded slope, Hampden, Penobscot Co., Sept. 8, 1916, *Fernald & Long 14392* (ANSP); argillaceous ledges, Old Town, July 27, 1916, *Fernald & Long 14390* (ANSP, F, SM, US); damp, gravelly woods, Houlton, Aroostook Co., Aug. 26, 1897, *Fernald* (G); low woods, Orono, July 29, 1890, *Fernald* (ANSP, NY); moist banks, along St. Johns River, St. Francis, Aug. 25, 1893, *Fernald 87* (ANSP, C, CAS, G, K, NY, M, US); Bangor, *Hallowell* (BB, IAC); in woods on banks of Penobscot, Oldtowne, 1828, *Oakes* (G); banks of the Wassataquoik River, 1847, *Porter* (M); Seven Islands, Township 13, Ranges 14–15, river-bank, July 25, 1917, *St. John & Nichols 2449* (NY, US); banks of Wassataquoik, Aug. 1847, *Thurber* (F, G, NY); roadside ledge, Frenchville, Aug. 12, 1901, *Williams* (G); Ashland, Fort Kent Road, "Winterville," Aug. 9, 1901, *Williams* (G); on Allagash River, at "Eliza Hole," Aroostook Co., July 28, 1900 *Williams* (G); in loam, borders of spruce woods, Portage Lake, Aug. 9, 1901, *Williams, Robinson & Fernald 58* (ANSP, BG, B, CAS, D, DH, F, G, IAC, K, M, NY, SM, UC, US); banks of the Wassataquoik, common on the Penobscot and its tributaries, Aug. 1847, *Young* (G, NY, UC).

NEW HAMPSHIRE: open pastures, Lombard Hill, Colebrook, Coos Co., July 20, 1917, *Fernald & Pease 16624* (G).

VERMONT: Charlotte, July 28, 1881, *Hosford* (US); same locality and collector, Aug. 3, 1879 (C, F, G, IAC, M); same locality and collector, Aug. 13, 1878 (COP, G); sandy woods, Salem Lake, Derby, Sept. 3, 1931, *Pinkerton & Allen* (M); maple woods, West Woodstock, July 30, 1928, *Kittredge* (M).

MASSACHUSETTS: banks of Manhan River, Southampton, 1830, *Chapman* (M, NY).

NEW YORK: Trenton Falls, Aug. 9, 1883, *Haberer* (CAS, US); same locality, Aug. 18, 1902, *Haberer 601* (G, SM); Fairfield, Herkimer Co., *Hadley* (SM); without locality or date, *Hadley 1* (NY); Sylvan Beach, July 20, 1914, *House 5643* (SM); banks of the Hudson River, North Creek, Warren Co., Sept. 29, 1927, *House 15688* (G, SM); Cocheton, Aug. 1, 1887, *Poggenburg* (NY); Trenton Falls, Aug. 18, 1902, *Peck* (SM); Trenton Falls, Aug. 29, 1868, *Schaffer* (ANSP); Cocheton, July 1887, *Schrenk* (NY, SM).

MICHIGAN: St. Helena Island in northern Lake Michigan, July 19, 1886, *Arnold* (BB); Mackinac, July 17, 1881, *Boyce* (IAC); without locality, Aug. 28, 1892, *Dodge 352* (?) (M); near Port Huron, Aug. 16, 1892, *Dodge* (BB, F, G, US); same locality, Aug. 16, 1895, *Dodge* (US); Keweenaw Co., July 4, 1888, *Farwell 249* (UC); low grounds, Keweenaw Co., Aug. 1890, *Farwell 770* (G); Big Stone Bay, Emmet Co., piney-aspen woods, July 31, 1925, *Gates 14156* (S); weeds in trail in *Thuja* bog, Reese's, Douglas Lake, Cheboygan Co., June–Aug. 1917, *Gates & Gates 10716* (F, M); same locality, Aug. 12, 1916, *Gates & Gates 9768* (BB); Cedar Swamp, Boyne Falls, July 27, 1878, *Hill 179* (F); Isle Royale, July 21, 1889, *Holway* (IAC, NY); Cedar Swamp, Cheboygan, Aug. 20, 1890, *Kofoid* (G, M); moist soil in wet places, Grayling, July 28, 30, 1903, *Mell & Knopf* (M); Mackinac Island, July 28, 29, 1898, *Millspaugh 82* (F); Lake Superior, *Parry* (NY); Mackinac Island, 1888, *Puckner* (CAS); on Isle Royale and south shore of Lake Superior, Keweenah Point, 1862, *Robbins 102*

(G, M); Keweenah Point, 1863, *Robbins 95* (MU); without locality, Aug. 1887, *Root* (F); Chandler's Falls of the Escanaba River, Aug. 27, 1892, *Wheeler* (US); Thunder Bay Island, July 18, 1895, *Wheeler* (US); same locality and collector, Aug. 12, 1895 (NY); Harbor Springs, Aug. 10, 1890, *Wheeler* (F); Isle Royale, woods, mainland, Aug. 15–16, 1912, *Williamson 2218* (ANSP).

WISCONSIN: Pike River Falls, sandy pine woods, Aug. 18, 1884, *Hasse* (ANSP, NY); Menominee River banks, July 1892, *Schuette* (F); Lake Superior, Aug. 23, 1893, *Harper* (M); Minah R., Door Co., July 27, 28, 29, 31, 1887, *Schuette* (F, G, K, NY, US); Europe Lake, Ellison Bay, Door Co., July 18, 1918, *Stanton 19* (M); Cato Rapids, 1874, *Swezey 17* (US).

ILLINOIS: Grand Detour, *Porter* (BB); same locality, Aug. 5, 1865, *Smith* (ANSP); same locality, Aug. 5, 1866, *Smith 5026* (BB).

MINNESOTA: pine woods, Lake Itaska, July 1891, *Aiton* (BB, NY, US); Benedict, Norway-Jack pine forest, July 10, 1914, *Bergman 2948* (NY); dry pine lands, Itaska Co., Aug. 1891, *Burglehaus* (M); Duluth, July 11, 1877, *Hall* (BB); Grand Marais, shore of the Bay and Lighthouse Point, Lake Superior, Aug. 9, 1920, *Rydberg 9619* (NY); Lake Itaska, pine woods, July 1891, *Sandberg* (CAS, F); Two Harbors, July 1, 1891, *Sandberg 457* (US); Grand Rapids, Aug. 6, 1891, *Sandberg 719* (US); woods and shores, Lake Co., shady woods, Itaska Lake, *Sandberg 1151* (F, US); Duluth, 1887, *Vasey* (US); north shore, Lake Superior, 1890, *Wheeler & Jones 1054* (G); Fond du Lac, July 19, 1889, *Woods* (US).

SOUTH DAKOTA: slate schist, under willows, North Rapid Ranger Station, alt. 1400 m., Black Hills National Forest, July 12, 1908, *Murdock 3072* (F, G, NY); woods south of Box Elder Creek, Lawrence Co., Aug. 3, 1924, *Over 16145* (US); Custer, alt. 1375 m., Aug. 15, 1892, *Rydberg 878* (NY, US); Nashy, Black Hills, July 25, 1912, *Visher 1557* (NY).

SASKATCHEWAN: 1857–8, Palliser's Brit. N. Am. Exped., *Bourgeau* (BG, G); Cumberland House Fort, *Drummond* (G, K).

MONTANA: Columbia Falls, *Mrs. J. J. Kennedy 38* (NY); same locality, July 17, 1892, *Williams 903* (C, NY, US).

ALBERTA: Rocky Mt. House, forest floor, open, Nordegg Distr., Sept. 24, 1928, *Brinkman 3678* (NY).

BRITISH COLUMBIA: Kicking Horse Valley, near Field, alt. 1000 m., July 21, 1906, *Brown 667* (ANSP, G, NY, US); Field, July 14, 1904, *Farr* (K); same locality, Aug. 18, 1909, *Olson* (G); between Field and Emerald Lake, Aug. 20, 1904, *Macoun 68734* (?) (NY); Ottertail, July 13, 1904, *Williamson* (ANSP).

CANADA WITHOUT LOCALITY: 1838, *Franklin & Douglas* (DH); "foret près de Fort Ellice" (rare), Aug. 26, 1857, *Bourgeau* (K); "Terra Hudsonica," 1837, *Grisebach* (BG); June 1849, *Leston* (DH); *MacNab* (K); 1869, *Macoun 77* (US); *Percival* (ANSP).

MEXICO: Très Marias Mts., alt. 2375 m., Morelos, Dec. 16, 1907, *Pringle 13971* (US); Rincón, alt. 2300 m., Morelia, April 1909, *Arsène 37* (US).

The Rothrock specimen listed from Labrador is from an early collection made before the Canadian boundaries were permanently established. No definite locality is given, and it is probable that Labrador is incorrect and that the plant actually came from a point further south. This is the case of the specimen collected

by Macfarlane and that by Martin as well, both, according to the label, from Caribou Island, Labrador. Caribou Island is now included in Nova Scotia. For this reason, it is doubtful if the area of distribution of the species proper extends as far north as Labrador.

23a. **H. deflexa** var. **Brentoniana** Gray, Syn. Fl. N. Am. ed. 2, 2^1: 127. 1886.

Halenia Brentoniana Griseb. Gen. & Sp. Gent. 325. 1839; Dietrich, Syn. Pl. **2**: 918. 1840; Hook. Fl. Bor.-Am. **2**: 67. *pl. 156*. 1840.

Tetragonanthus deflexus var. *Brentonianus* Britt. in Mem. Torr. Bot. Club **5**: 261. 1894; Britt. & Brown, Ill. Fl. **3**: 15. 1913.

T. Brentonianus Heller, Cat. N. Am. Pl. 6. 1898; Muhlenbergia **1**: 2. 1900.

Low plant, 0.3–1.5 dm. high; stem erect, much branched, nodes more approximate than in the species; leaves 3–5-nerved, the radical leaves similar to species, upper subsessile, oblong-lanceolate; inflorescence a 3-flowered cyme with the center flowers on long pedicels; corolla purple, .8–1.0 cm. long, tube .3–.5 cm. long; corolla-lobes ovate, acuminate, delicately veined, papillate; spurs broad or slender and subhorizontal; calyx .5–.7 cm. long, segments elliptical, acuminate, 3-veined, papillate; stamens approximately .2 cm. long; anthers broadly ovate; filaments linear.

Distribution: Labrador, southward to Nova Scotia and Quebec.

Specimens examined:

Labrador: Red Bay, Sept. 7, 1891, *Bowdoin College 290* (G); on the gneiss plain, in sand, Blanc Sablon, Str. Belle Isle, July 30, 1910, *Fernald & Wiegand 3909* (G, K, NY); damp sand, Forteau, Belle Isle, July 30, 1910, *Fernald, Wiegand & Kittredge 3910* (G); 1842, *Loring* (G); Battle Harbor, July 5, 1926, *Sewall & Weed* (F); Aug. 10, 1895, *Stearns* (US); hills, Forteau, Aug. 8, 1893, *Waghorne* (G, M, US); Battle Harbor, Aug. 6, 1913, *Williamson 559* (ANSP, NY); same locality, *Williamson 547* (ANSP, NY); on dry sandy hillside, under 100 m., Cartwright, Sandwich Bay, July 31, 1926, *Woodworth 357* (G).

Newfoundland: "lieux humides où secs et découverts à près du Pain de Suève, St. Pièrre," Aug. 19, 1901, *Louis-Arsène 365* (NY); "lieux humides où secs, découverts où boisés, mais plus généralement sans les bois où sous les buissons, St. Pièrre, Pain de Suève," Aug. 26, 1901, *Louis-Arsène 403* (G); 1776, *Banks* (BM); without locality or date, *Brenton 144a?* (K); Bay St. George, dry sandy field along shore, Aug. 12, 1908, *Eames & Godfrey 8030* (ANSP, G, K); turfy slopes of slaty hills, Little Quirpon, Quirpon Harbor, Aug. 6, 1925, *Fernald & Long 28950* (G, UC); boggy limestone barrens, Capstan Point, Flower Cove, Str. Belle Isle, July 28, 1924, *Fernald, Long*

& Dunbar 26982 (G); turfy limestone shore, sandy cove, Ingornachoix Bay, Aug. 9, 1924, *Fernald, Long & Dunbar 26983* (G, K); dry peaty barren, near Biscay Bay, Avalon Peninsula, Aug. 16, 1924, *Fernald, Long & Dunbar 26984* (G); by rills on seepy silicious slope of Joan Hill, Bay Bulls, Avalon Peninsula, Aug. 21, 1924, *Fernald, Long & Dunbar 26985* (G); in turf on granite ledges, Gaultois southern coast, Aug. 29, 1924, *Fernald, Long & Dunbar 26986* (G); peaty and gravelly open slopes, French or Tweed Island, Bay of Islands, Sept. 2, 1926, *Fernald, Long & Fogg 381* (G); wet moss and peat on gneiss hills near sand bank west of Burges, Distr. of Burges and LaPoile, Sept. 9, 1926, *Fernald, Long & Fogg 382* (G); grassy fields overlying conglomerate limestones and calcareous sandstones, Cowhead, Silurian coastal region north of St. Paul's Bay, July 22, 1910, *Fernald & Wiegand 3908* (G, US); wet mossy, turfy slopes of sandstone and arenaceous slate hills back of Carbonear, shores of Conception Bay, Avalon Peninsula, Aug. 6, 7, 1911, *Fernald & Wiegand 6081* (ANSP, BG, G, K, NY, UC); damp sandy shores, St. Georges, Aug. 13, 1910, *Fernald, Wiegand & Kittredge 3912* (G); springy swale and turfy upper border of strand, Anse aux Sauvages, Pistolet Bay, Aug. 11, 1925, *Fernald, Wiegand & Long 28951* (G); wet soil, top of exposed cliff, Belle Isle, Sept. 16, 1901, *Howe* (F); same locality, *Howe & Lang 1298, 1403* (G, NY); Port à Port, hillside on Cape St. George, 2 miles west, July 29, 1921, *Mackenzie & Griscom 10411* (G); Green Gardens, Cape St. George, July 25, 1922, *Mackenzie & Griscom 11135* (G); without locality, *Morison* (K); barrens, Flower Cove, Aug. 10, 1920, *Priest* (G); rocky hills, St. Johns, Aug. 1–19, 1894, *Robinson & Schrenk 180* (ANSP, BG, C, DH, G, K, NY, M, US); Barren Islands, Aug. 20, 1903, *Sornborger* (G, NY, US); Salmonier, Aug. 1885, *Thaxter* (G); dry turf, roadside, Old Perlican, Trinity Bay, Aug. 5, 1914, *Torrey 35* (G); Harbor Grace, Aug. 6, 1911, *Williamson 501* (ANSP); same locality, July 1, 1911, *Williamson 601* (NY).

Nova Scotia: damp soil of sea bluffs, Torbay, Aug. 22, 1901, *Howe* (F); exposed grassy seabluff, Money Point, Cape North, Cape Breton Island, Sept. 3, 1916, *Nichols 1901* (G); Grand Etang, Cape Breton, on exposed headland, Aug. 14, 1906, *Robinson 410* (NY).

Quebec: "sur les hauteurs des coteaux: Ile du Havre-aux-Maisons. Iles de la Madeleine," Aug. 14, 1919, *Marie-Victorin & Rolland-Germain 9647* (F, G); "Cap-aux-Meules, Ile de l'Etang-du-Nord. Iles de la Madeleine," Aug. 11, 1919, *Marie-Victorin & Rolland-Germain 9881* (G); "Natashquan: Ile à Charles, à l'entrée du Havre; sur le gneiss laurentien, Gulf St. Laurent," July 20, 1924, *Marie-Victorin & Rolland-Germain 18482* (ANSP, G); "Ile Kécarponi, Archipel de Kécarpoui, turfy shore, Labrador Peninsula, Saguenay Co.," Aug. 11, 1915, *St. John 90687* (G); Natashquan River, Saguenay Co., July 24–Aug. 10, 1912, *Townsend* (G).

Canada without Locality: 1828, *Despaux* (DH).

24. H. rhyacophila[52] Allen, n. sp.

Perennial with one to several erect floriferous stems, 2.5–6 dm. high, somewhat branched, slightly winged, internodes extremely

[52] **H. rhyacophila** Allen, sp. nov.—Perennis, caulibus 1-multis, erectis, floriferis, 2.5–6 dm. altis, aliquid ramosis, parvulum alatis; internodiis inferioribus, brevissimis (.5–2 cm.); ramis brevibus sterilibus foliosis radice saepe ascendentibus; foliis basalibus saepe in rosula densa, lanceolatis usque ellipticis, acutis, in petiolis longis attenuatis, 3–5-nerviis, medio-nervo prominenti, marginibus plus minusve undulatis,

short (.5–2 cm.) on lower portion of stem; short sterile leafy branches frequently arising from the root-stalk; basal leaves often in a dense rosette, lanceolate to elliptic, about 7 cm. long, acute, attenuate into long petioles, 3–5-nerved, with prominent midvein, margins more or less undulate; cauline leaves linear to linear-lanceolate, sessile or subsessile, acute, 1.5–3.5 cm. long; inflorescence pedunculate, terminal or axillary, loose, open, racemose, cymose, frequently of spike-like appearance; calyx .55–.9 cm. long, one-half to nearly three-fourths the length of the corolla; lobes 3-nerved, lanceolate, more or less attenuately acute, papillate; corolla .7–1.5 cm. long, .5–.8 cm. broad, tube one-third or less the length of the entirè corolla; corolla-lobes oval to ovate or obovate, acute to acuminate, margin crisped, usually papillate; spurs one-fourth to one-third the length of the entire corolla, slightly ascending; stamens .3–.5 cm. long; anthers oblong to oval; filaments linear; capsule broadly lanceolate, up to 1.5 cm. long; seeds elliptical, granular, brownish.

Distribution: known only from Costa Rica.

Specimens examined:

Costa Rica: Potrero del Alto, Volcan Poas, alt. 2461 m., Aug. 31, 1890, *Pittier 2975* (US); same locality, Aug. 1896, *Tonduz 10865* (US); *Pittier & Tonduz 10805* (B); "région supérieure du Cerro de Buena Vista," alt. 3000 m., Jan. 1891, *Pittier 3499* (B); "près du sommet del'Irazu," alt. 3000 m., July 10, 1891, *Tonduz 4316* (B); "près du sommet de les pelouses," Dec. 12, 1888, *Pittier 744* (B); Volcan Irazu, Dec. 31, 1910, *Cristan* (US); same locality, alt. 2275 m., 1923, *Lankester 670* (US); same locality, Aug. 4–5, 1920, *Rowlee & Stork 899* (NY, US); same locality, alt. 2250 m., March 1894, *Smith 4888* (F, G, US); same locality, alt. 2500 m., June 25, 1874, *Kuntze 2356* (K, NY); same locality, 1845–8, *Oersted 10772* (UC); in monte Reventado, alt. 2250 m., 1845–8, *Oersted 10773* (UC); *Warscewicz 216* (BG).

Pittier 2975 and *Oersted 10772, 10773* are not typical, since it is evident that the main axis has been broken, resulting in the

---

ca. 7 cm. longis; foliis caulinis linearibus vel lineari-lanceolatis, sessilibus subsessilibusve, acutis, 1.5–3.5 cm. longis; inflorescentia terminali axillarive, laxa, pedunculata, racemosa, cymosa, saepe spicata; calyce .55–.9 cm. longo, ½ usque ad ca. ¾ corollae longitudini adaequanti; lobis trinerviis, lanceolatis, plus minusve attenuate acutis, papillatis; corolla .7–1.5 cm. longa, .5–.8 cm. lata, tubo ⅓ vel minus totae corollae longitudini adaequanti; corollae lobis ovalibus usque ovatis vel obovatis, acutis usque acuminatis, plerumque papillatis, margine crispo; calcaribus ¼ usque ad ⅓ corollae longitudini adaequantibus, parvulum ascendentibus; staminibus .3–.5 cm. longis; antheris oblongis vel ovalibus; filamentis linearibus; capsula late lanceolata, usque ad 1.5 cm. longa; seminibus ellipticis, fulvis, granosis.—Costa Rica: Potrero del Alto, Volcan du Poas, alt. 2461 m., Aug. 31, 1890, *Pittier 2975* (US type).

formation of short stunted floral branches. Specimens collected by Friedrichstahl, now preserved at Kew and Geneva, are also possibly abnormal plants of *H. rhyacophila.*

24a. H. rhyacophila var. **procumbens**[53] Allen, n. var.

Stems 1–several, decumbent, the central larger, bearing most of the flowers; basal leaves few; foliose branches with very short internodes, sterile or bearing few flowers at tip; inflorescence erect, more or less strict and spike-like, many-flowered, similar to that of species; corolla greenish-white.

Distribution: Costa Rica.

Specimens examined:

COSTA RICA: wet thickets on the southern slopes of Volcan de Turrialba, near the Finca del Volcan de Turrialba, alt. 2000–2400 m., Feb. 22, 1924, *Standley 35285* (US TYPE).

The generally procumbent appearance of this specimen may be due to the fact that it was found growing in wet thickets.

24b. H. rhyacophila var. **macropoda**[54] Allen, n. var.

Stems 1–several, slightly branching, nodes remote; sterile branches frequently short, leafy, with short internodes; basal leaves few, lanceolate-elliptic, extremely acuminate, with long narrow petioles, 3-nerved; upper leaves broadly lanceolate, acuminate; inflorescence a loose racemose cyme; flowers usually borne on very long slender pedicels, more or less pendulous; corolla greenish-white; seeds oblong-ovoid, granular, wrinkled, yellow-brown. In other respects similar to species.

[53] **H. rhyacophila** var. **procumbens** Allen, var. nov.—Caulibus 1–compluribus, decumbentibus, centrali majori paucos flores gerenti foliis basalibus paucis; ramis foliosis, internodiis brevissimis, sterilibus vel summo paucos flores gerentibus; inflorescentia simile speciei, erecta, plus minusve stricta, spicata, multo-florifera; corolla viridi-candida.—COSTA RICA: wet thickets on the southern slopes of Volcan de Turrialba, near the Finca del Volcan de Turrialba, alt. 2000–2400 m., Feb. 22, 1924, *Standley 35285* (US TYPE).

[54] **H. rhyacophila** var. **macropoda** Allen, var. nov.—Caulibus 1–compluribus, parvulum ramosis, nodiis remotis; ramis saepe brevibus, foliosis, sterilibus, internodiis brevibus; foliis basalibus paucis, lanceolato-ellipticis, acuminatissimis, petiolis longis, angustis, 3-nerviis; foliis superioribus late lanceolatis, acuminatis; inflorescentia laxa, racemoso-cymosa; floribus plerumque pedicellis longissimis tenuibus, plus minusve pendentibus; corolla viridi-candida; seminibus oblongo-ovatis, granosis, rugosis, flavo-fulvis.—COSTA RICA: Volcan Poas, alt. 2678 m., Jan. 30, 1922, *Greenman & Greenman 5994* (M TYPE).

Distribution: Costa Rica.

Specimens examined:

COSTA RICA: common in wet forests on the southern slope of Volcan de Turrialba, near the Finca del Volcan de Turrialba, alt. 2000–2400 m., Feb. 22, 1924, *Standley 35141* (US); upper regions of the Volcan de Turrialba, alt. 2500–3400 m., Jan. 1, 1899, *Pittier 13076* (US); Volcan Poas, alt. 2678 m., Jan. 30, 1922, *Greenman & Greenman 5994* (M TYPE); lava fields, Irazu, 1854–55, *Hoffmann 119* (BG).

The last specimen cited from Mount Poas is more rigid than those from Turrialba, and the inflorescence is more open, but there is no doubt that it is the variety.

25. **H. Palmeri** Gray in Proc. Am. Acad. **21**: 401. 1886.

Tetragonanthus Palmeri Kuntze, Rev. Gen. Pl. **2**: 431. 1891.

Plant about 3–5 dm. high; stems simple or branched, striate; cauline leaves linear, sessile, faintly 3-nerved; lower leaves lanceolate, faintly 3-nerved, obtuse; inflorescence thyrsoid, many-flowered; calyx-segments .4–1.2 cm. long, lanceolate, acute, 3-nerved, midrib prominent, margin papillate; corolla 1–2.2 cm. long, yellow, tube .7–1.0 cm. long; corolla-lobes broadly ovate, acute, slightly auriculate, papillate; spurs tapering, incurved, ¼ the length of the entire corolla; anthers oblong; filaments linear, slightly uncinate; capsule about 15 cm. long, lanceolate, attenuate, subfalcate; seeds globose, dark brown, granular.

Distribution: mountains of northern and central Mexico.

Specimens examined:

MEXICO:

CHIHUAHUA: sixty miles south of Guadalupe y Calvo, Sierra Madres, alt. 1875–2125 m., Aug. 1898, *Nelson 4798* (K, US); Sierra Madres, near Colonia Garcia, alt. 1875 m., Sept. 4, 1899, *Townsend & Barber 303* (BG, BM, DH, F, G, M, NY, US); Marsh Lake, alt. 1750 m., Sept. 19, 1903, *Jones* (BM, D, M, US); without locality, Aug.–Nov. 1885, *Palmer 359* (ANSP, BM, G, IAC, K, NY, US).

DURANGO: without locality and date, *Garcia 410* (US).

26. **H. Conzattii** Greenm. in Publ. Field Mus. Bot. **2**: 335. 1912; Briq. in Candollea **4**: 318. 1931.

Erect branching herb, 2.5–3.7 dm. high; stem terete or angular, rather coarse; leaves sessile, lanceolate, ovate, subacute, 1–4 cm. long, 0.5–1 cm. broad, 3-nerved; basal leaves ovate-elliptic with petioles nearly equalling the blade; inflorescence terminal or seemingly axillary, but actually terminal on short branches less than 1 cm. long, pedicels up to nearly 2 cm. long; calyx-segments spatulate, 3-nerved, papillate; corolla .8–1.2 cm. long, .4–.65 cm.

broad, green or yellow-green; lobes .3–.5 cm. long, ovate, acute, papillate; spurs slender, incurved, .2 cm. long; stamens .2–.5 cm. long; anthers broadly ovate; filaments linear; capsule 1.1–1.8 cm. long, lanceolate, subfalcate; seeds globose-ovoid, yellow-brown, granular.

Distribution: State of Oaxaca, Mexico.

Specimens examined:

OAXACA: Sierra de San Felipe, alt. 2500 m., Sept. 15, 1894, *Pringle 4908* (ANSP, BG, CAS, D, DH, G, IAC, K, M, NY, US, V); Cerro San Felipe, alt. 2375–2750 m., 1894, *Nelson 1115* (G, US); same locality and date, *Nelson 1164* (US); same locality, alt. 2000 m., Sept. 20, 1908, *Conzatti 2295* (F); same locality, alt. 2500 m., Sept. 1, 1894, *Smith 236* (M); 18 miles southwest of the city of Oaxaca, alt. 1875–2375 m., Sept. 10–20, 1894, *Nelson 1340* (US); cerro Grande de Huanclilla, distrito de Nochistlan, alt. 2520 m., Oct. 13, 1921, *Conzatti 4265* (US); Cumbre de Ixtepec, 1842, *Liebmann 10771* (UC); Mont Tanga, 2000 m., 184–, *Galeotti 1489* (B).

MEXICO, WITHOUT LOCALITY: *Jurgensen 812* (DH, K).

27. **H. Schiedeana** (Schl. & Cham.) Griseb. Gen. & Sp. Gent. 327. 1839; DC. Prodr. **9**: 130. 1845; Hemsl. Biol. Cent.-Am. Bot. **2**: 353. 1882.

Swertia Michauxiana Schl. & Cham. in Linnaea **5**: 122. 1830, excl. syn.

Tetragonanthus Schiedeanus Kuntze, Rev. Gen. Pl. **2**: 431. 1891.

Halenia chlorantha Greenm. in Proc. Am. Acad. **41**: 240. 1905.

Annual, 2–6.5 dm. high; stems erect, simple below, frequently branched above, narrowly winged; basal leaves ovate, 2 cm. long, 1.5 cm. broad, length of petioles equalling that of blade, gradually decreasing toward the summit; cauline leaves petiolate, ovate to broadly lanceolate, 3–6 cm. long, 1.5–2 cm. broad, 3–5-nerved, acute; inflorescence terminating the stem and branches in several-flowered cymose clusters; pedicels erect, 1.5 cm. or less in length; calyx-segments lanceolate-elliptic, conspicuously papillate, approximately .5 cm. long, 3-nerved, lateral veins near the margin, usually strongly reflexed; corolla .8–1.1 cm. long, greenish; tube nearly equalling the obovate abruptly acuminate papillate lobes; spurs .2–.3 cm. long, tapering, tips glandular, nearly parallel with the tube, slightly incurved; stamens .2 cm. long; filaments linear; capsule oblong, subfalcate, 1.2 cm. long; seeds globose, yellow-brown, granular.

Distribution: wet woods of Central Mexico.

Specimens examined:

Mexico: Serro de Colorado, Aug. 1828–9, *Schiede & Deppe 248* (BG type).

Hidalgo: wet woods near Trinidad Iron Works, alt. 1425 m., July 11, 1904, *Pringle 8939* (ANSP, BG, BM, C type of *H. chlorantha*, CAS, DH, K, M, NY, S, UC, US, V).

Vera Cruz: Chiconguiaco, Sierra Madre, Aug. 1912, *Purpus 6011* (CAS).

28. H. caleoides[55] Allen, n. sp.

Perennial with thick leafy angled, more or less decumbent stem, bearing short leafy branches at central nodes and more elongate floral branches above; leaves conspicuously decurrent on stem; lower cauline leaves about 12 cm. long, lanceolate-elliptic, acute, 3-nerved; midvein prominent, attenuate into broad petiole about 2.5 cm. long; upper cauline leaves subsessile or very slightly petiolate, lanceolate, acute, 3-nerved; inflorescence a subumbellate axillary or terminal cyme; flowers on angled, rather pendulous peduncles, less than 2 cm. long; calyx about equalling the corolla; segments lanceolate, acuminate, reticulately veined at tip, papillate; corolla about 1.2 cm. long, greenish, tube about equalling the lobes; lobes broadly triangular, apiculate, papillate, margin crisped; spurs pendulous, shorter than the corolla; anthers ovate-oblong, filaments linear; capsule immature.

Distribution: Guatemala.

Specimens examined:

Guatemala: vicinity of Agua, alt. 2700–3000 m., March 22, 1905, *Maxon & Hay 3675* (US type); "wasservulcan bei Santa Maria," alt. 3000–4000 m., *Scherzer* (V).

29. H. platyphylla[56] Allen, n. sp.

[55] **H. caleoides** Allen, sp. nov.—Perennis, caule crasso, folioso, angulato, plus minusve decumbenti, centralibus nodiis ramos breves foliosos, et supra ramos elongatiores floriferos gerenti; foliis conspicue decurrentibus; foliis inferioribus caulinis ca. 12 cm. longis, lanceolato-ellipticis, acutis, 3-nerviis, medio-nervo prominente, in petiolis latis attenuatis, ca. 2.5 cm. longis; foliis superioribus caulinis subsessilibus vel parvulum petiolatis, lanceolatis, acutis, 3-nerviis; inflorescentia cymosa, subumbellata, axillari terminalive; floribus in pedunculis angulatis, aliquam pendentibus, minusquam 2 cm. longis; calyce corollae subaequanti, segmentibus lanceolatis, acuminatis, summo reticulato-nerviis, papillatis; corolla ca. 1.2 cm. longa, viride; tubo lobis subaequanti; lobis late triangularibus, apiculatis, papillatis, margine crispo; calcaribus pendulis, corolla brevioribus; antheris ovato-oblongis, filamentis linearibus; capsula immatura.—Guatemala: vicinity of Agua, alt. 2700–3000 m., March 22, 1905, *Maxon & Hay 3675* (US type).

[56] **H. platyphylla** Allen, sp. nov.—Perennis erectus, ca. 3.5 dm. altus, 1–2 caulibus floriferis globo denso foliorum basalium in verticillis in caulibus brevibus caespitosis

Erect perennial, about 3.5 dm. high; 1–2 flowering stems, arising from a dense bushy rosette of basal leaves borne in whorls on short caespitose sterile stems springing from a heavy ligneous root; stems narrowly winged, more or less erect; basal leaves elliptic to lanceolate, petioles persistent, longer than blade, acuminate, prominently 3-nerved; 1–several pairs of cauline leaves, the upper subtending 1–2 flowers, with increasingly shorter petioles the more remote the nodes from the base; inflorescence usually a terminal subumbellate cyme, with pedicels of varying length up to 2 cm.; calyx foliaceous, oblanceolate-ovate, acuminate, two-thirds to three-fourths the length of the corolla, margin crisped, 3-nerved, reticulate at tip, papillate; corolla 1.3 cm. long, tube about one-half the length of the entire corolla; lobes ovate, margins more or less crisped, acute; slender spurs, about one-third the length of the corolla, tips incurved and pendulous; filaments linear; capsule lanceolate; seeds immature.

Distribution: known only from the type locality.

Specimens examined:

GUATEMALA: Volcan de Agua, Dept. Zacatepequez, alt. 2875 m., April 1890, *Smith 2170* (G TYPE, US).

30. H. nudicaulis Mart. & Gal. in Bull. Acad. Brux. **11**[1]: 371. 1844; Hemsl. Biol. Cent.-Am. Bot. **2**: 352. 1882.

Halenia Purpusi Brandegee, Zoe **5**: 235. 1906.

Halenia scapiformis Briq. in Candollea **4**: 322. 1931.

Perennial, 1.4–3 dm. high, often branched from or near the base; root ligneous; stem angled; radical leaves elliptic to lanceolate, 2–10 cm. long, attenuate into a long persistent petiole,

---

sterilibus gestorum ascendentibus, ex radice crasso ligneo aptis; caulibus anguste alatis, plus minusve erectis; foliis basalibus ellipticis usque lanceolatis, petiolis persistentibus, longioribus quam lamina, acuminatis, prominente trinerviis, 1-pluribus geminis foliorum caulinorum, superioribus 1–2 flores subtendentibus, petiolis deinceps brevioribus remotioribus a basi nodiis; inflorescentia plerumque terminali, subumbellata, cymosa, pedicellis usque 2 cm. longis; calyce folioso, oblanceolato-ovato, acuminato, ⅔ usque ¾ corollae longitudini adaequanti, margine crispo, ad apicem 3-nerviis, reticulatis, papillatis; corolla 1.3 cm. longa, tubo ½ totae corollae longitudini adaequanti; lobis ovatis, marginibus plus minusve crispis, acutis; calcaribus tenuibus, acuminis incurvatis pendentibusque, circa ⅓ corollae longitudini adaequantibus; filamentis linearibus; capsula lanceolata; seminibus immaturis.—GUATEMALA: Volcan de Agua, Dept. Zacatepequez, alt. 2875 m., April 1890, *J. D. Smith 2170* (G TYPE, US).

3-nerved, midvein prominent; cauline leaves linear to broadly elliptic, 1–2 pairs, more or less reduced; inflorescence cymose, 4–6 terminal or axillary flowers on pedicels .2–1.5 cm. long; calyx-segments oblong, .2–.5 cm. long, 3-nerved, acute to abruptly acuminate; corolla .7–1 cm. long, white, tube .25–.4 cm. long, with minute protuberances or reduced, apparently glandular, incurved spurs about midway up the tube; corolla-lobes ovate-oblong, often mucronate; stamens approximately .2 cm. long, uncinate; stigmatic surfaces reflexed; capsule lanceolate, exserted, slightly curved; seeds globose, brown, granular.

Distribution: subalpine meadows of southern Mexico.

Specimens examined:

VERA CRUZ: Mt. Orizaba, alt. 2500 m., July 1841, *Liebmann 10778* (BG, UC); same locality, alt. 2500–2750 m., Aug. 1840, *Galeotti 7220* (B TYPE, DH, V).

PUEBLA: Chinanthe, alt. 1750–2000 m., May 1841, *Liebmann 10776* (BG, UC); same locality, 1841–3, *Liebmann* (NY).

MEXICO: Ixtaccihuatl, Oct. 1905, *Purpus 1760* (BG, CAS, F, G, M, US); Popocatepetl, Sept. 1908, *Purpus 3070* (BG, BM, CAS, DH, F, G, M, NY, US); Lecima, Sierra de Ajusco, Aug. 18, 1896, *Harshberger 137* pp. (ANSP).

OAXACA: Mont Tanga, alt. 2000–2250 m., July 1840, *Galeotti 1488* (B, DH); near Reyes, alt. 1875–2600 m., Oct. 17, 1894, *Nelson 1748* (US); vicinity of Cerro San Felipe, alt. 2375–2750 m., 1894, *Nelson 1096* (G, US); northwest summit of Mt. Zempoaltepec, alt. 2500–2750 m., July 5–13, 1894, *Nelson 652* (US); same locality, alt. 2850 m., *Nelson 636* pp. (US).

SOUTH MEXICO: without locality: *Liebmann 10774* (UC); *Ehrenberg 608* (BG); Sierra San Pedro Nolasco, 1843–4, *Jurgensen 811* (DH, K).

31. **H. plantaginea** (HBK.) Griseb. Gen. & Sp. Gent. 327. 1839; Dietrich, Syn. Pl. **2**: 918. 1840; Griseb. in DC. Prodr. **9**: 130. 1845; Wedd. Chlor. And. **2**: 75. 1859; Hemsl. Biol. Cent.-Am. Bot. **2**: 352. 1882; Conzatti, Fl. Syn. Mex. 174. 1897.

Swertia plantaginea HBK. Nov. Gen. & Sp. Pl. **3**: 175. 1818; Kunth, Syn. Pl. **2**: 266. 1823.

Halenia elongata D. Don ex G. Don, Gen. Hist. **4**: 177. 1838.

H. nutans Mart. & Gal. in Bull. Acad. Brux. **11**^{1}: 371. 1844.

Tetragonanthus plantagineus Kuntze, Rev. Gen. Pl. **2**: 431. 1891.

Perennial, 1.5–3.5 dm. high; stems 1–many, narrowly winged, erect, simple below, frequently bearing short floriferous branches above; basal leaves numerous, in a rosette, lanceolate, elliptic to ovate, 3-nerved, 2–5 cm. long, .5–1 cm. broad, obtuse to acute,

or apiculate, petioles persistent; cauline leaves 1–2 pairs, sessile, linear to lanceolate, 2–3 cm. long, the upper usually subtending floriferous branches; inflorescence a terminal or axillary cyme, individual floral clusters of varying density, pedicels slender, slightly curved, .5–2.2 cm. long; calyx-segments lanceolate-elliptic, acute to abruptly acuminate, papillate, one-third to one-half the length of the corolla, 3-nerved; corolla yellow, campanulate, extremely narrowed at the base, 1–1.5 cm. long, tube not quite equalling the lobes; lobes ovate, obtuse to acute; spurs extremely slender, appressed, incurved at tip, one-third to one-half the length of the entire corolla; filaments linear; anthers ovate; capsule elliptical, subfalcate, 1.5–1.8 cm. long, .5 cm. broad; seeds subglobose, brown, granular.

Distribution: mountains of Mexico.

Specimens examined:

Vera Cruz: pine forests, Citlaltepetl, alt. 2750–3000 m., Sept. 1907, *Purpus 2766* (BG, BM, CAS, F, G, M, NY, US); Mt. Orizaba, alt. 3250 m., Sept. 1841, *Liebmann 10780* (UC); same locality, July 25–26, 1901, *Rose & Hay 5730* (US); same locality, Sept. 28, 1828, *Schiede & Deppe 246* (BG, BM, M, V); same locality, Aug. 6, 1891, *Seaton 205* (C, G, NY, US); same locality, *Galeotti 7222* (B type of *H. nutans*, V).

Oaxaca: "in summo monte San Felipe," July, April 1834, *Andrieux 226* (DH, G, K, V).

Hidalgo: Sierra de Pachuca, July 21–22, 1901, *Rose & Hay 5569* (US); same locality, alt. 2500 m., Aug. 22, 1902, *Pringle 11033* (BG, F, G, K, M, NY, US); between Pachuca and Real del Monte, Aug. 31, 1903, *Rose & Painter 6665* (G, US); Real del Monte, *Coulter 939* (BM, G, K, NY).

Mexico: Monte de Rio Frio, road from Mexico City to Pueblo, alt. 4000 m., July 31, 1929, *Mexia 2693* (US, M).

Michoacan: "In monte Jorullo," alt. 3000 m., *Humboldt & Bonpland* (BG type of *Swertia plantaginea*).

South Mexico, without Locality: *D. Don* (K type of *H. elongata*); coll. of 1845, *Woelfflin* (NY); *Wawra 424, 952* (V); coll. of 1830, *Karwinsky 122* (V).

31a. H. plantaginea f. grandiflora[57] Allen, n. forma.

Similar to species, but a larger more sturdy plant with heavier root system, frequently more than 6 stems, usually branched

[57] **H. plantaginea** f. **grandiflora** Allen, forma nov.—Similis speciei, sed herba major, robustior, radice crassiori, caulibus saepe plusquam sex, plerumque supra ramosis; foliis basalibus multis, petiolis longis, tenuibus, persistentibus, plerumque lanceolatis, 3–5-nerviis, obtusis acutisve; inflorescentia multo-florifera plerumque densiori majorive quam speciei; corolla 1.2–2.5 cm. longa, latiora et dilatatiora summo quam speciei; calcaribus totae corollae ca. ⅙ longitudini adaequantibus; calyce ca. ½ vel minus corollae longitudini adaequanti.—Mexico: Nevado de Toluca, Sept. 2, 1892, *Pringle 4224* (ANSP, BG, BM, B, C, CAS, G, M type, NY, K, S, US).

above; numerous basal leaves for the most part lanceolate, 3–5-nerved, obtuse or acute, petioles long, slender, persistent; inflorescence many-flowered, usually more dense than the species; flowers larger; corolla 1.2–2.5 cm. long, broader than in the species and more expanded at the tip; spurs approximately one-third the length of the entire corolla; calyx approximately one-half or less than one-half the length of the corolla.

Distribution: mountains of Mexico.

Specimens examined:

MEXICO:

MEXICO: near Salazar, Sept. 14, 1903, *Rose & Painter 7025* (US); Nevado de Toluca, Oct. 16, 1903, *Rose & Painter 7964* (NY, US); same locality, Oct. 15, 1903, *Rose & Painter 7910* (US); same locality, Sept. 2, 1892, *Pringle 4224* (ANSP, BG, BM, B, C, CAS, DH, G, M TYPE, NY, K, S, US, V); same locality, *Heller 391* (V); Cerro de San Miguel, Nov. 1912, *Salazar* (US); Sierra de las Cruces, Sept. 14, 1903, *Pringle* (UC); near Orizaba, alt. 2500–3000 m., Aug. 1838, *Linden 935* (K).

OAXACA: Sierra de San Felipe, alt. 2500 m., June 23, 1894, *Pringle 4720* (ANSP, BG, B, BM, CAS, DH, G, IAC, K, M, NY, S, UC, US, V).

MORELIA: Loma La Huerta, Nov. 1911, *Arsène* (DH, US).

MICHOACAN: Angangueo, 1837, *Hartweg 347* (BG, BM, DH, NY).

The form *grandiflora* appears to be only a variation, due merely to habitat, moisture, or some nutritional factor. It has no distinctive geographical distribution. It may be noted that the specimens cited from Hidalgo under the species are all alike in having slightly more round basal leaves, though aside from this character, they could not be distinguished from the type specimen of *plantaginea*.

32. **H. Shannonii** Briq. in Candollea **4**: 321. 1931.

Erect plant, less than 2 dm. high; stems mostly simple, angled, frequently more than one arising from the base; leaves somewhat fleshy with sunken veins; basal leaves narrowly oblanceolate, petiolate, acute, 3.5–7 cm. long, .3–.6 cm. broad, 3-nerved; cauline leaves 2–3 pairs, oblanceolate to lanceolate, acute, sessile, 3-nerved; inflorescence axillary or terminal, several-flowered subumbellate cymes, pedicels .7–2.5 cm. long, curved at tip, angled; calyx foliaceous, one-half to two-thirds the length of the corolla; calyx-segments oblong-elliptic, .6–.9 cm. long, abruptly acuminate, reticulate, 3-nerved, papillate; corolla nearly 1.5 cm. long, tube almost one-half the length of the entire corolla; lobes ovate, obtuse to acutish, margins irregularly crenulate, papillate; spurs

divaricate, slightly incurved, pointed; anthers ovate, filaments linear; capsule immature.

Distribution: volcanic regions of Guatemala.

Specimens examined:

GUATEMALA: Volcan de Agua, Dept. Zacatepequez, alt. 2000 m., June 1892, *Shannon 3630* (US); same locality, alt. 3100 m., Aug. 1892, *Shannon 3613* (G, DH TYPE, M, K, US); same locality, alt. 3400–3752 m., March 22, 1905, *Pittier 39* (US); Volcan de Fuego, 1861, *Salvin & Godman 311, 249* (K); same locality, alt. 3000 m., Nov. 17, 1873, *Salvin* (K).

32a. **H. Shannonii** f. **compacta**[58] Allen, n. forma.

Stem shorter than in species; leaves broader than in species, elliptic, acuminate; inflorescence similar to species but less open, more clustered; flowers on shorter pedicels.

Distribution: known only from type locality.

Specimens examined:

GUATEMALA: mountains above Chiantla, Huehuetenango, May 29, 1906, *Cook 45* (US TYPE).

33. **H. decumbens** Benth. Pl. Hartw. 67. 1840; Griseb. in DC. Prodr. **9**: 130. 1845; Hemsl. Biol. Cent.-Am. Bot. **2**: 351. 1882, excl. syn.

Halenia longicornu Mart. & Gal. in Bull. Acad. Brux. **11**[1]: 370. 1844; Hemsl. Biol. Cent.-Am. Bot. **2**: 352. 1882.

H. apiculata Mart. & Gal. Bull. Acad. Brux. **11**[1]: 371. 1844.

Tetragonanthus decumbens Kuntze, Rev. Gen. Pl. **2**: 431. 1891.

T. longicornis Kuntze, Rev. Gen. Pl. **2**: 431. 1891.

Perennial, 1.5–3.5 dm. high; stems more or less decumbent, frequently short sterile branches arising from the root with a dozen or more leaves clustered at the tip; fertile branches ascending, simple, striate, angled; basal leaves with long petioles, almost equalling the blade, elliptical to broadly elliptical-oval, 3 cm. or less in length, .6–1.2 cm. broad, midrib prominent, faintly 3-nerved, subacute; 1–5 pairs of cauline leaves, with petioles increasingly shorter toward the tip, the upper sessile, subconnate, elliptical to lanceolate, 1–2.5 cm. long, .4–.8 cm. broad, very faintly 3-nerved, acute, midrib prominent; inflores-

[58] **H. Shannonii f. compacta** Allen, forma nov.—Caule breviori quam speciei; foliis latioribus, ellipticis, acuminatis; inflorescentia simili speciei sed densiore, confertiora; floribus in brevioribus pedicellis.—GUATEMALA: Chiantla, Huehuetenango, May 29, 1906, *Cook 45* (US TYPE).

cence terminal or axillary in upper pair of leaves, forming a several-flowered cymose cluster; upper pedicels erect, 2 cm. or less long, the lower frequently pendulous, usually shorter, 4-angled; calyx-segments oblong to elliptic, acute or abruptly acuminate, 3-nerved, papillate, over one-half the length of the corolla excluding the spurs; corolla 1–1.5 cm. long, lobes elliptic-oval, delicately veined, papillate, margin slightly crisped or apiculate; corolla-tube slightly more than one-half the length of the entire corolla; spurs .5–.7 cm. long, .2 cm. broad at the base, tapering at the tip, spreading, descending and incurved; stamens about .2 cm. long; anthers ovate, filaments linear; capsule .8–1 cm. long, .3–.5 cm. broad, broadly elliptical; seeds subglobose, depressed, brownish, granular.

Distribution: mountains of Mexico.

Specimens examined:

MEXICO:

OAXACA: "in monte Pelado, dictionis Oaxacacae," 1841, *Hartweg 494* (BM, DH, K TYPE, NY, V); from Monte Pelado and on Tanetze, east-northeast from Oaxaca, July, 1845, *Jurgensen 386* (DH, K); "cordillera, Cerra San Felipe, hautes montes," alt. 2000–2375 m., April–Sept. 1840, *Galeotti 7166* (B TYPE of *H. longicornu*, DH TYPE of *H. apiculata*, K, M fragment, V); northwest slope of Mt. Zempoaltepec, alt. 2000–2500 m., July 10, 1894, *Nelson 698* (US); same locality, June 1842, *Liebmann 10770* (UC); summit of Mt. Zempoaltepec, alt. 2800 m., July 9, 1894, *Nelson 636* pp. (US).

34. **H. guatemalensis** Loesener in Verh. Bot. Ver. Brandenb. 55: 182. 1913.

Perennial, 2.5–4 dm. high; stem subterete, internodes 7–12 cm. long; leaves prominently decurrent; basal leaves oblanceolate, attenuate into long narrow petioles, 3–6 cm. long, 1–1.5 cm. broad, acute or abruptly acuminate; lower cauline leaves petiolate, 3-nerved, obtuse or subrotund at apex, abruptly apiculate; upper cauline leaves sessile or subsessile, 2–3 pairs, elliptic-ovate to lanceolate; inflorescence terminal, subumbellate, 2–7 flowers, the lower hardly shorter than the cauline leaves, a single or two flowers inserted below the umbel in the axils of the higher leaves; pedicels striate, tetrangular, 3 cm. or less long; calyx about two-thirds the length of the corolla, segments obovate-spatulate, mucronulate, 3-nerved, reticulate; corolla yellow-green, about 2 cm. long; lobes ovate or oval, subacute at apex, many-nerved; spurs one-half the length of the entire corolla, narrow, slightly

spreading, descending and curved inward at the tip; stamens approximately .2 cm. long; anthers subovoid; capsule subrostriform, about 1.8 cm. long, .5–.6 cm. broad; seeds globose, depressed, granular.

Distribution: Guatemala.

Specimens examined:

GUATEMALA: Huehuetenango, Todos los Santos, road near Chiantla, alt. 3000 m., Sept. 11, 1896, *Seler & Seler 2728* (BG TYPE); Nebaj, Dept. Quiché, alt. 2300 m., April 1890, *Heyde & Lux 4729* (BM, G, K, US); mountains near Hacienda of Chaucol, alt. 2750, Jan. 2, 1896, *Nelson 3646a* (US).

34a. H. guatemalensis var. latifolia (Loesener) Allen, n. comb.

Halenia plantaginea var. *latifolia* Loesener in Verh. Bot. Ver. Brandenb. **55**: 182. 1913.

Habit similar to that of the species, but smaller and more rigid.

Distribution: Guatemala.

Specimens examined:

GUATEMALA: "Huehuetenango, Bergwald oberh. Todos los Santos," alt. 2800–3000 m., June 19, 1896, *Seler & Seler 3086* (BG TYPE).

KEY TO SOUTH AMERICAN SPECIES AND VARIETIES

1. Spurs usually pendulous and incurved.
  2. Spurs reduced to small protuberances, less than ¼ the length of corolla.
    3. Flowers .5–.6 cm. long.
      4. Flowers single, apical, or disposed in 1–3-flowered cymes .... *35. H. valerianoides*
      4. Flowers more numerous (usually 5), subumbellate........ *36. H. pusilla*
    3. Flowers about 1 cm. or more long.
      4. Calyx-segments spatulate........................... *37. H. spatulata*
      4. Calyx-segments usually oblong-lanceolate.......... .. *38. H. caespitosa*
  2. Spurs conspicuous, ¼–½ the length of corolla.
    3. Stems sterile, densely leafy; leaves fleshy or coriaceous.
      4. Leaves lanceolate or oblong-lanceolate.............. *39. H. hypericoides*
      4. Leaves obovate.................................... *40. H. pulchella*
      4. Leaves linear...................................... *41. H. pinifolia*
    3. Sterile stems none; leaves thin, herbaceous.
      4. Stem single; rosette absent............................ *42. H. gracilis*
      4. Stems 1–many; rosette present in complete plant.
        5. Flowers 1–1.5 cm. long; plant yellow-green........... *43. H. Killipii*
        5. Flowers less than 1 cm. long (except in *H. Weberbaueri*); plant not yellow-green.
          6. Flowering stem scapiform, almost aphyllous; flowers 5 or less. .... *44. H. Mathewsii*
          6. Flowering stem leafy; flowers more than 5.
            7. Leaves linear, narrowly linear-lanceolate.
              8. Plant less than 20 cm. high.

9. Plant more than 10 cm. high; flowers .6–.7 cm. long.... ....*45. H. vincetoxicoides*
9. Plant less than 10 cm. high; flowers 1.2–1.5 cm. long.... ....*46. H. Weberbaueri*
8. Plant more than 25 cm. high..................*47 H. Stuebelii*
7. Leaves ovate-lanceolate to oblong-lanceolate; stem stout, rigid.......................................*48. H. robusta*
2. Spurs conspicuous, ½–¾ the length of the corolla.
3. Stem decumbent, suffruticose; leaves subcoriaceous......*49. H. taruga gasso*
3. Stem usually erect, not suffruticose.
4. Flower 2–3 cm. long..................................*50. H. gigantea*
4. Flower less than 1.5 cm. long.
5. Leaves less than .8 cm. long.........................*51. H. minima*
5. Leaves more than .8 cm. long.
6. Flowering stems curved at apex..................*52. H. penduliflora*
6. Flowering stems erect.
7. Pedicels scarcely 1 cm. long; flowers in dense heads.
8. Cauline leaves oblong, hardly narrowed at base.......... ....*53. H. phyteumoides*
8. Cauline leaves lanceolate or oblong-lanceolate, gradually elongated into petiole, dilated at base.........*54. H. Herzogii*
7. Pedicels more than 1 cm. long; flowers more loosely clustered.
8. Flowers less than 1 cm. long..................*55. H. silenoides*
8. Flowers more than 1 cm. long.
9. Spurs slender, more or less parallel; plant more than 15 cm. high..........................*56. H. umbellata*
9. Spurs thick, distinctly incurved at tip; plant usually less than 15 cm. high..................*57. H. Meyeri Johannis*
1. Spurs pendulous, divaricate.
2. Spurs scarcely ¾ the length of the corolla, more or less divergent at tip.
3. Stems and branches densely and long-ciliate.............*58. H. barbicaulis*
3. Stems and branches not ciliate, smooth.
4. Pedicels of apical flowers more than 1.5 cm. long.
5. Leaves ovate to obovate-lanceolate....................*59. H. Rusbyi*
5. Leaves linear or linear-lanceolate.
6. Plant more than 10 cm. high, not caespitose.........*60. H. Purdieana*
6. Plant less than 10 cm. high, densely caespitose.............. ....*60a. H. Purdieana* var. *congesta*
4. Pedicels of apical flowers less than 1.5 cm. long..........*61. H. Hieronymi*
2. Spurs ½–¾ the length of the corolla, horizontally or subhorizontally divaricate, but incurved at apex.
3. Stem strict; sterile branches none; basal leaves rigid and erect, disposed in a dense rosette...............................*62. H. bifida*
3. Stems more or less flexuous; sterile branches numerous; basal leaves not rigid, occasionally recurved, not disposed in a dense rosette... ....*63. H. Weddelliana*
1. Spurs horizontal or reflexed.
2. Flowers 3–4 cm. long...................................*64. H. elegans*
2. Flowers less than 2 cm. long.

3. Flowers less than 1 cm. long .... *65. H. Hoppii*
3. Flowers more than 1 cm. long.
    4. Sepals ovate-lanceolate.
        5. Leaves thin, herbaceous, no rosette; spurs thick ...... *66. H. asclepiadea*
        5. Leaves subcoriaceous; dense, many-leaved rosette; spurs slender. .... *67. H. Kalbreyeri*
    4. Sepals obovate or oblanceolate.
        5. Rosette and lower leaves lanceolate, slightly narrowed at base into a short petiole .... *68. H. bella*
        5. Rosette and lower leaves obovate, long-petiolate ..... *69. H. sphagnicola*

35. **H. valerianoides** Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 106. 1916.

Small caespitose perennial, less than .5 dm. high; root very thick and densely branching; stems short, erect, 2–3 cm. high, almost leafless, arising from a dense rosette of basal leaves; basal leaves thick, petiolate, oblanceolate, 2–3 cm. long, .4 cm. broad, acute, obsoletely 3-nerved; cauline leaves broadly sessile, 1 pair or none, ovate-oblong, .5–.6 cm. long, .2–.3 cm. broad; inflorescence a terminal 1–3-flowered cyme, pedicels .7–1.0 cm. long; calyx-lobes obovate-oblong, .3 cm. long, .2 cm. broad, acute, obsoletely 3-nerved; corolla approximately .5 cm. long, .4 cm. broad, tube slightly less than one-half the length of the entire corolla; lobes ovate, acute; spurs small laterally prominent protuberances at the base of the corolla.

Distribution: Peru and Bolivia.

Specimens examined:

PERU: (TYPE not seen, *Weberbauer 1676*, BG, M photo). According to Gilg, this number is incorrect, since the data given does not agree with the specimen.

BOLIVIA: Chacaltaya, 130 klm. from La Paz, alt. 4800 m., Feb. 1908, *Buchtien 1484* (US); Alaska Mine, alt. about 4500 m., March 1–4, 1926, *Tate 67* (NY).

36. **H. pusilla** Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 107. 1916.

H. Dombeyana var. *brevicornis* Wedd. Chlor. And. **2**: 76. 1859, fide Gilg, *l. c.*

Perennial caespitose herb, under .5 dm. high; root short, thick, covered with remains of marcescent leaves, bearing at the apex a dense rosette of leaves; flowering stems numerous, densely crowded, erect, short; rosette leaves petiolate, very thick, oblanceolate, 1–1.5 cm. long, .2–.3 cm. broad, acute, obsoletely 3-nerved; cauline leaves 1–2 pairs, closely approximated, sessile,

ovate-oblong to oblong, .6–.7 cm. long, .3–.35 cm. broad; inflorescence a few-flowered (5 usually) cyme, pedicels up to 1 cm. long; calyx-lobes oblong-lanceolate, .5 cm. long, .2 cm. broad, acute, obsoletely 3-nerved; corolla .5–.6 cm. long, tube about one-half the length of the entire corolla; lobes ovate, acute; spurs small laterally prominent protuberances at the base of the corolla; stamens about .2 cm. long; filaments linear; anthers ovate, tip attenuate; capsule ovate.

Distribution: Bolivia and Peru.

Specimens examined:

BOLIVIA: Prov. Larecaja, on road to Lacatia, in meadows, in vicinity of Sorata, alt. 3200–3700 m., *Mandon 369* pp. (V).

PERU: Cerro de Pasco, alt. about 4600 m., March 28, 1923, *MacBride 3072* (F, M); Piñasniocj, Panticalla Pass, alt. 3600 m., June 18, 1915, *Cook & Gilbert 1793* (US).

37. **H. spatulata**[59] Allen, n. sp.

Perennial caespitose herb, up to .8 dm. high; root coarse, woody; 1–2 flowering stems, erect, simple or rarely branched from base, occasional short sterile leafy branches; numerous basal leaves attenuate into long petioles, elliptic to spatulate, up to 2.5 cm. long, .4–.5 cm. broad, prominently uninerviate; cauline leaves 1–2 pairs, sessile, elliptic, less than 1 cm. long; inflorescence usually terminal, 1–few-flowered cyme, pedicels erect or slightly recurved at tip; calyx-lobes spatulate, up to .6 cm. long, .2 cm. broad, 3-nerved; corolla 1 cm. long, "lime green," tube over one-half the length of the entire corolla; lobes broadly ovate, acute; spurs approximately one-fourth the length of the corolla, pendulous and incurved, broad at the base, attenuate at tip; stamens

[59] **H. spatulata** Allen, sp. nov.—Herba perennis, caespitosa, usque ad .8 dm. alta; radice crassa, lignea; 1–2 caulibus floriferis, erectis, simplicibus vel raro e baso ramosis, vel ramis brevibus sterilibus foliosis; foliis basalibus multis, longis petiolis attenuatis, ellipticis vel spatulatis, usque ad 2.5 cm. longis, .4–.5 cm. latis, prominente 1-nerviis; foliis caulinis 1–2 geminis, sessilibus, ellipticis, minusquam 1 cm. longis; inflorescentia plerumque terminali, cymosa, 1–pauco-florifera; pedicellis erectis vel ad apicem parum recurvatis; calycis lobis spatulatis, usque ad .6 cm. longis, .2 cm. latis, 3-nerviis; corolla 1 cm. longa, "viride"; tubo plusquam ½ corollae longitudini adaequanti; lobis late ovatis, acutis; calcaribus ¼ corollae longitudini subaequanti, pendulis incurvatisque, ad basin latis, ad apicem attenuatis; staminibus ca. .2 cm. longis; filamentis linearibus; antheris ovatis; capsula late lanceolata; stigmatibus truncatis, planis superficiebus, ut videtur, stigmaticibus.—PERU: Dept. Cusco, open, grassy páramo, Cerro de Colquipata, alt. 3900–4000 m., May 1, 1925, *Pennell 13749* (ANSP TYPE, NY, US).

about .2 cm. long; filaments linear, anthers ovate; capsule broadly lanceolate; stigmas truncate, the flat surfaces apparently stigmatic.

Distribution: Peru.

Specimens examined:

Peru: Dept. Cusco, open grassy páramo, Cerro de Colquipata, alt. 3900–4000 m., May 1, 1925, *Pennell 13749* (ANSP type, NY, US).

38. **H. caespitosa** Gilg in Fedde, Rep. Spec. Nov. **2**: 53. 1906; Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 107. 1916.

Small caespitose herb, forming a broad dense mat .5–.8 dm. in diameter, usually .4–.5 dm. high, the flowering stems frequently reaching a height of 1–1.5 dm.; sterile branches usually intermingled with the fertile; leaves in dense aggregation, very fleshy, petiolate, obovate-lanceolate to oblanceolate, 1.5–2 cm. long, about .3–.4 cm. broad, acute, nerves scarcely conspicuous; cauline leaves, when present, sessile, oblong-lanceolate to linear-lanceolate, 1–2 cm. long; inflorescence usually consisting of a 1-, rarely 2–3-, flowered cyme at the apex of the fertile stem, pedicels 1.6–2 cm. long, erect or slightly nodding; calyx-lobes oblanceolate to oblong-lanceolate, .6–.8 cm. long, .2 cm. broad, acute to obtusish, 3-nerved; corolla about 1 cm. long, greenish, length of tube nearly equalling that of the entire corolla; lobes ovate, subrotund, crisped; spurs pendant, .1–.2 cm. long and almost as thick; stamens approximately .4 cm. long, attached just below the sinus; filaments linear, anthers ovate; capsule linear.

Distribution: moist places in Peru.

Specimens examined:

Peru: Oroya, near Lima, alt. 3300–3600 m., 1919, *Kalenborn 91*[60] (M, US); wet stream margin, Morococha, May 23, 1922, *Macbride & Featherstone 898* (F, M); "Hacienda Arapa bei Yauli, an der Lima-Oroya-Bahn," alt. 4400 m., 1906, *Weberbauer 279* (BG type, DH, M photo).

39. **H. hypericoides**' (HBK.) G. Don, Gen. Hist. **4**: 177. 1838; Griseb. Gen. & Sp. Gent. 328. 1839.

Swertia hypericoides HBK. Nov. Gen. & Sp. Pl. **3**: 176. 1818; Roem. & Schult. Syst. Veg. **6**: 76. 1820.

Perennial herb; stem procumbent, branching, leafy, less than

[60] The specimen in the Herbarium of the Missouri Botanical Garden was collected by *Margaret Kalenborn, No. 91.* That from the United States National Herbarium bears the same number, but the collector is *A. S. Kalenborn.* In all probability these are the same collection.

.3 dm. high; lower leaves several pairs, approximate, petiolate, sheathing at base, oblong-lanceolate or lanceolate, 2 cm. long, acute, 3-nerved; upper leaves smaller, sessile, oblong; inflorescence terminal and axillary many-flowered panicles, pedicels up to 1.5 cm. long; calyx-lobes linear-lanceolate, about .5 cm. long; corolla .7–.8 cm. long, yellowish; lobes ovate, acute; spurs pendulous, incurved, subconical, about one-half the length of the corolla; filaments linear, anthers oblong; capsule oblong, obtuse, compressed; seeds subglobose, blackish brown, smooth.

Distribution: Colombia.

No specimen examined, but description compiled from original publication and photograph. (TYPE, *Humboldt & Bonpland*, HJP, M photo).

40. **H. pulchella** Gilg in Engl. Bot. Jahrb. **54:** Beibl. 118, p. 107. 1916.

Perennial herb, .5–1.0 dm. high; root thick, elongate; axis elongate, more or less procumbent, densely covered with obsolete remains of leaves, the apex curved-erect, sending out a single loosely leafy flowering stem, and some few (3–5) sterile procumbent or curved-erect leafy branches 3–13 cm. long; rosette leaves lacking; lower cauline leaves broadly petiolate, upper sessile, rather fleshy, obovate, 1.2–1.6 cm. long, .5–.6 cm. broad, manifestly 3-nerved, veins sunken above, prominent below, acute; inflorescence composed of terminal and axillary pseudoracemose 3-flowered cymes, more or less approximate, pedicels .6–1.2 cm. long; leaves subtending inflorescence, minute, euphylloid; calyx-lobes oblong-lanceolate to oblanceolate, about .8 cm. long, .25–.3 cm. broad, 3-nerved, margin hirtellous; corolla about 1 cm. long, tube less than one-half the length of the entire corolla; lobes ovate, somewhat acute, auriculate; spurs pendulous, incurved, about one-half the length of the corolla; stamens about .2 cm. long; filaments linear, anthers ovate.

Distribution: Ecuador.

Specimens examined:

ECUADOR: in the Andes, *Jameson 53* (DH TYPE, M photo, V).

Very similar to *H. Weddelliana*, but rather stouter, more leafy, and spurs less divergent.

41. **H. pinifolia** (R. & P.) G. Don, Gen. Hist. **4:** 177. 1838.
Swertia pinifolia (R. & P.) ex Don, *l. c.*

Perennial herb, growing in tufts, .7–1.5 cm. high; stems erect, simple; leaves linear, channeled, acute, edges scabrous; inflorescence umbellate; calyx-lobes ovate-lanceolate, acute; corolla golden-yellow; spurs straight, one-half as long as the corolla.

Distribution: cordilleras of the Andes of Peru.

No specimens examined, but description compiled from original publication. (TYPE, *Ruiz & Pavon*—Herbarium at Madrid).

42. **H. gracilis** (HBK.) G. Don, Gen. Hist. **4**: 177. 1838; Griseb. Gen. & Sp. Gent. 327. 1839; DC. Prodr. **9**: 130. 1845 (excl. var.).

Swertia gracilis HBK. Nov. Gen. & Sp. Pl. **3**: 170. 1818.

Halenia pichinchensis Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 109. 1916.

H. Jamesoni Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 115. 1916.

Annual herb, up to 3 dm. high; stem simple, erect, minutely striate; few basal leaves suggesting a rosette, usually fugacious, with persistent bases, broadly elliptic to ovate, attenuate into narrow petioles longer than the blade, up to 3 cm. long, up to 1 cm. broad, acute, prominently 3-nerved; cauline leaves up to 5 pairs, at intervals of 4 cm., petiolate, elliptic, becoming broadly lanceolate toward the summit of the stem, acute, 3-nerved; floral leaves smaller than cauline; inflorescence few-flowered (2–6) axillary and terminal cymes, erect pedicels up to 1.2 cm. long; calyx-lobes more or less obovate, papillate, approximately .6 cm. long, .2 cm. broad, abruptly acuminate, 3-nerved, reticulate at tip; corolla 1–1.5 cm. long, greenish, tube one-half the length of the entire corolla; lobes ovate, acuminate; spurs slightly less than one-third the length of the corolla, very slender, slightly divergent, the tip frequently, but not always, slightly incurved; stamens approximately .3 cm. long, attached just below the summit of the tube; filaments linear, anthers oval, abruptly acuminate; stigmas broad, recurved; capsule lanceolate, subfalcate, 1.8 cm. long; seeds reticulate.

Distribution: Colombia and Ecuador.

Specimens examined:

COLOMBIA: Zipaquira, alt. 2730 m., *Humboldt & Bonpland* (HJP TYPE, M photo).

ECUADOR: Pichincha, *Karsten* (BG, V); on Mt. Pichincha, opposite Quito, March 3, 1920, *Heilborn 437* (V); La Planta del Chillo, about Tanque, alt. 2700 m., April

2, 1920, *Firmin 697* (US); near Quito, coll. of 1864, *Jameson* (V); about Quito, *Jameson* (ANSP, BG); Guagrapata, *Spruce 5131* (V).

Halenia gracilis shows a marked relationship to *Halenia Schiedeana* of Mexico. The specimens which Gilg has described as *H. Jamesoni* and *H. pichinchensis* appear to be conspecific with *gracilis*. In the opinion of the author, the only possible difference is the texture of the leaves, which in the *Jamesoni* specimen is slightly rougher than that of the *gracilis* type.

43. **H. Killipii**[61] Allen, n. sp.

Pale green perennial, .3–2.5 dm. high; root coarse, heavy, ligneous, covered with darkened remains of leaves; stem stout, conspicuously alate; basal leaves few, fleshy, in rosette, attenuate into long petioles, oblanceolate, 2–4 cm. long, .3–.35 cm. broad, 3-nerved, obtuse; cauline leaves 1–3 pairs, sessile, linear-lanceolate, 1.5–2.5 cm. long, .3 cm. broad, inconspicuously 3-nerved, obtuse; inflorescence 1 (rarely 7)-flowered, usually terminal, subumbellate cyme, pedicels erect or slightly nodding, up to 2.5 cm. long; calyx-lobes elliptic, .5–.9 cm. long, yellowish-green, acute, obsoletely 3-nerved; corolla 1–1.5 cm. long, tube about one-third the length of the entire corolla; lobes broadly ovate, erose; spurs thick, pendulous, incurved, about one-third the length of the corolla; stamens about .2 cm. long; filaments linear, anthers ovate; capsule ovate, attenuate at apex, yellowish-green.

Distribution: Peru.

Specimens examined:

Peru: Dept. Junín, Mount La Juntay, near Huancayo, alt. 4700 m., April 27, 1929, *Killip & Smith 22087* (US type); same locality and date, *Killip & Smith 22088* (US).

---

[61] H. Killipii Allen, sp. nov.—Herba perennis, pallida viride, .3–2.5 dm. alta; radice crassa, lignea, reliquiis foliorum tecta; caule robusto, conspicue alato; foliis basalibus paucis, carnosis, in rosula, petiolis longis attenuatis, oblanceolatis, 2–4 cm. longis, .3–.35 cm. latis, 3-nerviis, obtusis; foliis caulinis 1–3 geminis, sessilibus, lineari-lanceolatis, 1.5–2.5 cm. longis, .3 cm. latis, inconspicue 3-nerviis, obtusis; inflorescentia 1 (raro 7)-florifera, plerumque terminali, subumbellata-cymosa; pedicellis erectis vel parum nutantibus, usque ad 2.5 cm. longis; calycis lobis ellipticis, .5–.9 cm. longis, flavo-viridibus, acutis, obsolete 3-nerviis; corolla 1–1.5 cm. longa; tubo ca. ⅓ corollae longitudini adaequanti; lobis late ovatis, erosis; calcaribus crassis, pendulis, incurvatis, ca. ⅓ corollae longitudini adaequanti; staminibus .2 cm. longis; filamentis linearibus, antheris ovatis; capsula ovata, apice attenuati, flavo-viride.—Peru: Dept. Junin, Mt. La Juntay, near Huancayo, alt. 4700 m., April 27, 1929, *Killip & Smith 22087* (US type); same locality and date, *Killip & Smith 22088* (US).

44. H. Mathewsii Gilg in Engl. Bot. Jahrb. **54:** Beibl. 118, p. 111. 1916.

H. asclepiadea Griseb. Gen. & Sp. Gent. 326. 1839; in DC. Prodr. **9:** 129. 1845, pp; non *Swertia asclepiadea* HBK. fide Gilg, *l. c.*

Perennial herb, up to 2.5 dm. high (usually less than 1.5 dm.); subterranean axis thick, short, erect; numerous flowering stems erect, slender, sparingly leafy; basal leaves in dense rosette, herbaceous, petiolate, obovate-oblong, up to 2.5 cm. long, .4–.5 cm. broad, the lowest equal and equidistant on the stem, the uppermost sessile and much reduced, oblong or ovate-oblong, more or less acute, obsoletely or inconspicuously 5-nerved; inflorescence a 5-flowered cyme, on a more or less scapiform stem; pedicels of terminal flowers 2 cm. long, of laterals 1.5 cm., decreasing toward the base; calyx-lobes oblanceolate, about .55 cm. long, acute, obsoletely 3-nerved; corolla about .7 cm. long, tube about one-third the length of the entire corolla; lobes ovate-oblong, subrotund; spurs pendulous, slightly incurved, one-third the length of the corolla.

Distribution: Peru.

Specimens examined:

Peru: near Huamatanga, *Mathews 523* (V type); Dept. Lima, swale on páramo, near Antaicocha, Cerro Colorado, east of Canta, alt. 4000–4200 m., June 20, 1925, *Pennell 14678* (ANSP, NY, S, US); Dept. Lima, open hillside, Rio Blanco, alt. 3000–3500 m., April 15–17, 1929, *Killip & Smith 21737* (US).

45. H. vincetoxicoides Gilg in Engl. Bot. Jahrb. **54:** Beibl. 118, p. 108. 1916.

Tetragonanthus Whitei Rusby in Mem. N. Y. Bot. Gard. **7:** 321. 1927.

Perennial herb, 1.5–2 dm. high; stems 1–5, simple, arising from tuft of basal leaves which may or may not be persistent, internodes up to 8 cm. long; basal leaves numerous, attenuate into long petioles, narrowly elliptic, 1.5–2.5 cm. long, .2–.45 cm. broad, acute; cauline leaves 2–3 pairs, sessile, subconnate, lanceolate, 1.5–3.5 cm. long, up to .4 cm. broad, 3-nerved, midvein prominent; inflorescence axillary and terminal many-flowered (6–14) subumbellate cymes; pedicels usually recurved at tip, 2.5 cm. long; calyx-lobes oblanceolate-elliptic, papillate, up to .55 cm. long, .25 cm. broad, acute, 3-nerved, reticulate at tip; corolla

.6–.7 cm. long, yellowish, tube one-half the length of the entire corolla; lobes ovate-oblong, papillate, acute, margin inrolled and erose; spurs one-fourth length of corolla, slender, slightly spreading, incurved at tip; stamens approximately .3 cm. long, attached at summit of tube; filaments linear, anthers broadly ovate; stigma only slightly reflexed, capsule up to 1 cm. long, subfalcate; seeds subglobose, reticulate, greenish yellow, brown.

Distribution: moist grassy meadows of Bolivia.

Specimens examined:

BOLIVIA: Yungas, 1890, *Bang 665* (BG TYPE, G, M, NY, US, V); Sorata, alt. 3300 m., Feb. 1886, *Rusby 669* (G, M, NY, US, V); Pongo, alt. 3800 m., July 11, 1921, *White 178* (NY TYPE of *Tetragonanthus Whitei* Rusby).

This last-cited specimen was described as *Tetragonanthus Whitei* Rusby, but accords exactly with *H. vincetoxicoides* Gilg, except for its small size.

46. H. Weberbaueri[62] Allen, n. sp.

Perennial herb, caespitose, .5–1 dm. high; root fibrous, covered with darkened remains of leaves; stems usually several, rather stout; basal leaves numerous, attenuate into long slender petioles equalling the blade in length, oblanceolate to lanceolate, 2.5–3.5 cm. long, .2–.4 cm. broad, obtuse, 3-nerved; cauline leaves sessile, 1 pair at extreme base of stem, linear-lanceolate, 3–4 cm. long, .2–.3 cm. broad, obtuse, 3-nerved; inflorescence 3–5-flowered terminal subumbellate cymes with occasional depauperate 1-flowered cymes in axils of cauline leaves, pedicels .6–2 cm. long, erect or curving at the tips; calyx-lobes broadly oblanceolate to

[62] **H. Weberbaueri** Allen, sp. nov.—Herba perennis, caespitosa, .5–1 dm. alta; radice fibrata, reliquiis foliorum tecta; caulibus plerumque pluribus, aliquid robustis; foliis basalibus multis, petiolis longis tenuibus laminae longitudini adaequantibus attenuatis, 2.5–3.5 cm. longis, .2–.4 cm. latis, obtusis, 3-nerviis; foliis caulinis, sessilibus, plerumque ad basin caulis, 1-geminis, lineari-lanceolatis, 3–4 cm. longis, .2–.3 cm. latis, obtusis, 3-nerviis; inflorescentia 3–5 florifera, terminali, subumbellata-cymosa, per occasionem depauperata 1-florifera foliorum caulinium axillibus; pedicellis .6–2 cm. longis, erectis, vel ad apicem curvatis; calycis lobis late oblanceolatis vel attenuate obovato-ellipticis, .4–.6 cm. longis, acutis vel obtusis, 3-nerviis; corolla 1.2–1.5 cm. longa, viridula; tubo circiter ½ totae corollae longitudini adaequanti; lobis ovatis, acutis, erosis; calcaribus ⅙ corollae longitudini adaequantibus, tenuibus, pendulis, saepe parum divaricatis, sed semper ad apicem incurvatis; staminibus minusquam .2 cm. longis; filamentis linearibus, antheris ovatis; capsula lanceolata, ad apicem attenuata.—PERU: rocks, Mt. Razuhuillca, Prov. Huanta, Dept. Ayacucho, alt. 4300–4500 m., Feb. 4–6, 1926, *Weberbauer 7498* (F TYPE).

narrowly obovate-elliptic, .4–.6 cm. long, acute to obtuse, 3-nerved; corolla 1.2–1.5 cm. long, greenish, tube about one-half the length of the entire corolla; lobes ovate, acute, erose; spurs one-third the length of the corolla, slender, pendulous, often slightly divaricate but always incurved at the tips; stamens less than .2 cm. long; filaments linear, anthers ovate; capsule lanceolate, attenuate at tip.

Distribution: Peru.

Specimens examined:

Peru: rocks, Mt. Razuhuillca, Prov. Huanta, Dept. Ayacucho, alt. 4300–4500 m., Feb. 4–6, 1926, *Weberbauer 7498* (F TYPE).

47. **H. Stuebelii** Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 110. 1916.

Biennial, up to 3–4 dm. high; stem thick, erect, simple or branching at base; basal leaves in dense rosette, narrowed at base, lanceolate, 3–3.5 cm. long, .3–.4 cm. broad, acute; cauline leaves thickly herbaceous, sessile, oblong-lanceolate, 2–5 cm. long, .3 cm. broad, the uppermost smaller, obsolete, narrowly acuminate, 5-nerved, veins sunken above, prominent below; inflorescence a terminal dense many-flowered (5–7–9) subcapitate cyme, and axillary 1–few-flowered (3, rarely 5) cymes, pedicels 1–2.7 cm. long; calyx-lobes lanceolate, .7–.8 cm. long, .25 cm. broad, acute, obsoletely 3–5-nerved; corolla almost 1 cm. long, tube approximately one-third the length of the entire corolla; lobes ovate-oblong, acute; spurs pendulous, incurved, about one-third the length of the corolla.

Distribution: Peru.

Specimens examined:

Peru: Rio Blanco, about 5000 m., May 20–25, 1923, *Macbride 3040* (F, M). (TYPE not seen, *Stübel 49e*, BG, M photo).

48. **H. robusta** Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 110. 1916.

Biennial herb, up to 3 dm. high; ligneous unbranched tap-root; stems 1–3, simple or branching below or above, erect, sturdy, up to .3 cm. thick, striate, internodes up to 6 cm. long; numerous basal leaves in rosette, attenuate into narrower petiole, broadly elliptic, 2–2.5 cm. long, .6 cm. broad, acute-acuminate, 3-nerved,

nerves appearing sunken from above, prominent below; cauline leaves 1–3 pairs, sessile, elliptic, up to 4 cm. long, .65 cm. broad, 3–5-nerved, acute; inflorescence axillary and terminal many-flowered (6–15) subumbelliform cymes; pedicel sturdy, slightly recurved at tip, up to 3 cm. long; calyx-lobes oblong to ovate, approximately .5 cm. long, .25 cm. broad, acute, papillate, uninerviate, tip reticulate; corolla up to .7 cm. long, yellow, tube slightly less than one-half the length of the entire corolla; lobes narrowly ovate, acute; spurs borne at the midpoint of the corolla-tube, tiny, slender, scarcely one-fourth the length of the corolla, tip incurved; stamens about .25 cm. long, inserted at the summit of the tube; filaments linear, anthers ovate-oval; capsule up to 1.3 cm. long, ovate; seeds oval, reticulate.

Distribution: near snow line in Bolivia.

Specimens examined:

BOLIVIA: near snow line, Mt. Tunari, near Cochabamba, 1891, *Bang 1019* (ANSP, BG TYPE, F, G, M, NY, US, V); Dept. Cochabamba, Prov. Chaparé, Ceja-region, La Aduana, alt. 3000 m., March 7, 1927, *Steinbach 9535* (M, NY, S).

49. **H. taruga gasso** Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 117. 1916.

Suffruticose perennial, ligneous, more or less decumbent, up to 1.5 dm. high; root frequently sending up one or more short sterile densely leafy stems; flowering stems simple, leafy, rather slender; basal leaves, if present, petiolate, subcoriaceous, in dense spirals about lower portion of stem, lanceolate or linear-lanceolate, up to 2 cm. long, .35 cm. broad, acute; cauline leaves more or less sessile, more linear, otherwise similar to basal leaves; inflorescence usually a terminal many-flowered (6) cyme, pedicels up to 1 cm. long; calyx-lobes oblong-elliptic, acute, 3-nerved, reticulate at tip; corolla up to 1.3 cm. long, greenish-yellow, tube approximately one-fourth the length of the entire corolla; lobes ovate, acute; spurs almost one-half the length of the corolla, slender, spreading, tip incurved or divergent; stamens about 2 cm. long; filaments linear, anthers ovate; capsule oblong-ovate, subfalcate, up to 1.3 cm. long; seeds subglobose, reticulate.

Distribution: Ecuador.

Specimens examined:

ECUADOR: Loja, alt. 3000–3500 m., *Lehmann 4878* (BG TYPE, M photo); Cañar, Sept. 15, 1918, *Rose & Rose 22674* (NY, US); Mt. Pittshum, *Jameson* (G).

50. H. gigantea[63] Allen, n. sp.

Stout coarse perennial, up to 4 dm. high; root thick, ligneous, up to .5 cm. in diameter; axis subhorizontal or horizontal, coarse, fleshy, .5–.6 cm. in diameter, covered with dense coarse black remains of leaves; stems 1–many, coarse, erect, simple, internodes up to 7 cm. long; numerous basal leaves, in dense rosette, herbaceous, narrowed into petioles equalling the blade in length, dilated and almost sheathing at the base, lanceolate, 5–10 cm. long, .6–1 cm. broad, attenuate-acuminate, 3–5-nerved; cauline leaves about 3 pairs, sessile, lanceolate, 2–3 cm. long, decreasing in length toward the summit, .5 cm. broad, acuminate, 3-nerved; inflorescence a loose terminal usually 3-flowered cyme, pedicels up to 5 cm. long, erect; calyx-lobes ovate to ovate-oblong to oblong, up to 1.5 cm. long, .5 cm. broad, acute, often with suggestion of apicule, 3–many-nerved; corolla 3–4 cm. long, light green, tube less than one-third the length of the entire corolla; lobes oblong-ovate, acute, more or less erose, frequently subapiculate; spurs coarse, about one-third the length of the corolla, pendulous, incurved, the tip heavily glandular; stamens nearly 1 cm. long; filaments linear, anthers ovate, acuminate; capsule lanceolate.

Distribution: Colombia.

Specimens examined:

COLOMBIA: Dept. Santander, Páramo de Santurbán, near Vetas, alt. 3950–4160

[63] **H. gigantea** Allen, sp. nov.—Herba perennis, robusta, crassa, usque ad 4 dm. alta; radice crassa, lignea, usque ad .5 cm. in diametro; axe subhorizontale horizontaleve, crasso, carnoso, usque ad .5–.6 cm. in diametro, reliquiis foliorum densis crassis tecto; caulibus 1–multis, crassis, erectis, simplicibus, internodiis usque ad 7 cm. longis; foliis basalibus multis, in rosula densa, herbescentibus, petiolis laminae longitudini adaequantibus attenuatis, dilatatis et prope ad basin vaginantibus, lanceolatis, 5–10 cm. longis, .6–1 cm. latis, attenuate acuminatis, 3–5-nerviis; foliis caulinis ca. 3 geminis, sessilibus, lanceolatis, 2–3 cm. longis, decrescentibus sursum, .5 cm. latis, acuminatis, 3-nerviis; inflorescentia laxa, cymosa, terminali, plerumque 3-florifera, pedicellis usque ad 5 cm. longis, erectis; calycis lobis ovatis vel ovato-oblongis vel oblongis, usque ad 1.5 cm. longis, .5 cm. latis, acutis, saepe subapiculatis, 3–multi-nerviis; corolla 3–4 cm. longa, pallida viride; tubo minusquam ⅓ corollae longitudini adaequanti; lobis oblongo-ovatis, acutis, plus minusve erosis, saepe subapiculatis; calcaribus crassis, ca. ⅓ corollae longitudini adaequantibus, pendulosis, incurvatis, ad apicem dense glandulosis; staminibus ca. 1 cm. longis; filamentis linearibus; antheris ovatis, acuminatis; capsula lanceolata.—COLOMBIA: Dept. Santander, Páramo de Santurbán, near Vetas, alt. 3950–4160 m., Jan. 17 1927, *Killip & Smith 17566* (M TYPE, NY, US).

m., Jan. 17, 1927, *Killip & Smith 17566* (M TYPE, NY, US); same locality, *Killip & Smith 17521* (US); same locality, *Killip & Smith 17516* (M, NY, US).

51. H. minima[64] Allen, n. sp.

Small perennial, caespitose, .6 dm. or less high; root ligneous; frequently numerous short sterile leafy stems up to 2.5 cm. high; flowering stems 1–2 cm. high, erect, slender, almost scapiform, simple; basal leaves in dense rosette, thick, coarse, attenuate into petioles shorter than blades, broadly oblanceolate, less than 1 cm. long, .2–.3 cm. broad, acute, obsoletely 3-nerved; leaves of sterile branches abruptly narrowed into petioles, exceeding blades in length, elliptic, up to .8 cm. long, .2 cm. broad, acute, obsoletely 3-nerved, midvein prominent; cauline leaves 1 pair at base, a second pair subtending the inflorescence, sessile, oblanceolate, .3–.7 cm. long, .2 cm. broad, acute to acuminate, obsoletely nerved; inflorescence a 2–4-flowered terminal loose cyme, pedicels 1.5 cm. long, slightly curved at apex; calyx-lobes oblong-oblanceolate, .4–.5 cm. long, .1–.15 cm. broad, acute, obsoletely 3-nerved; corolla .6–.8 cm. long, tube one-half the length of the entire corolla; lobes ovate, acute; spurs slender, pendulous, slightly incurved, between one-third and one-half the length of the corolla; stamens about .2 cm. long; filaments linear, anthers ovate; capsule ovate, attenuate at apex.

Distribution: Ecuador.

Specimens examined:

ECUADOR: Andes, coll. of 1855, *Couthouy* (G TYPE, NY).

---

[64] **H. minima** Allen, sp. nov.—Herba perennis, parva, caespitosa, .6 dm. minusve alta; radice lignea; saepe caulibus multis, brevibus, sterilibus, foliosis, usque ad 2.5 cm. altis; caulibus floriferis 1–2 cm. altis, erectis, tenuibus, prope scapiformibus, simplicibus; foliis basalibus in rosula densa, crassis, petiolis brevioribus laminis attenuatis, late oblanceolatis, minusquam 1 cm. longis, .2–.3 cm. latis, acutis, obsolete 3-nerviis; foliis ramorum sterilium petiolis longioribus laminis subito attenuatis, ellipticis, usque ad .8 cm. longis, .2 cm. latis, acutis, obsolete 3-nerviis, medio-nervo prominenti; foliis caulinis ad basin 1-geminis, alio gemine inflorescentiam subtendenti, sessilibus, oblanceolatis, .3–.7 cm. longis, .2 cm. latis, acutis vel acuminatis, obsolete 3-nerviis; inflorescentia 2–4-florifera, terminali, laxa, cymosa, pedicellis 1.5 cm. longis, ad apicem parum curvatis; calycis lobis oblongo-oblanceolatis, .4–.5 cm. longis, .1–.15 cm. latis, acutis, obsolete 3-nerviis; corolla .6–.8 cm. longa; tubo ½ corollae longitudini adaequanti; lobis ovatis, acutis; calcaribus tenuibus, pendulis, parum incurvatis, ⅓–½ corollae longitudini adaequantibus; staminibus ca. .2 cm. longis; filamentis linearibus, antheris ovatis; capsula ovata, ad apicem attenuata.—ECUADOR: Andes, coll. of 1855, *Couthouy* (G TYPE).

52. H. penduliflora Gilg in Engl. Bot. Jahrb. **54:** Beibl. 118, p. 116. 1916.

H. Dombeyana var. α Wedd. Chlor. And. **2:** 76. 1859 pp.

Biennial, up to 3 dm. high; root fibrous, axis thick, short, covered with remains of marcescent leaves; stem single, simple, erect, curved at apex; basal leaves in loose rosette, herbaceous, petiolate, oblong-lanceolate to elliptic, 4 cm. long, .5–.6 cm. broad, acute; cauline leaves 3 pairs or so, slightly narrowed at base, but sessile, oblong, 2–3 cm. long, .5–.7 cm. broad, acute, 3-nerved; inflorescence a 7–11-flowered subumbellate terminal cyme, always pendulous, rarely an axillary small 3-flowered cyme, pedicels 1.5 cm. long; calyx-lobes oblanceolate to oblong-oblanceolate, about .8 cm. long, .2–.5 cm. broad, obsoletely 3-nerved; corolla 1–1.2 cm. long, tube scarcely one-third the length of the entire corolla; lobes ovate, acute; spurs pendulous, slightly divergent, but incurved at tips about one-third to three-fourths the length of the corolla; stamens about .4 cm. long; filaments linear, anthers ovate; capsule ovate, attenuate at apex.

Distribution: Bolivia.

Specimens examined:

Bolivia: near Lacatia, in stony meadow, alt. 3200–3700 m., *Mandon 369* pp. (G, M photo, NY, S, V).

The specimen of *Halenia penduliflora* Gilg, based on *Mandon 369* pp., has the same floral characteristics as *silenoides* and bears the label "in graminosis," which signifies a possible ecological variation. The habit is that of typical specimens of *silenoides*, which, having grown in grassy situation, has become attenuate, with the internodes more elongate, the stem more or less decumbent. However, until more material is available the species *penduliflora* must be retained.

53. H. phyteumoides Gilg in Engl. Bot. Jahrb. **54:** Beibl. 118, p. 112. 1916.

Perennial caespitose herb, up to 1.2 dm. high; root short, thick, densely fibrous, with very short axis; stem lateral, erect, simple, thick, angled; basal leaves in dense rosette, attenuate into long petioles equalling the blades in length, spatulate or broadly oblanceolate, up to 2.5 cm. long, .35 cm. broad, acute, obsoletely 3-nerved; cauline leaves 1–2 pairs, slightly narrowed at base, but

sessile, thick, 1–1.5 cm. long, decreasing toward the summit, .3–.4 cm. broad, acute, obsoletely 3-nerved; inflorescence a terminal 5-flowered subcapitate cyme and axillary 3-flowered cymes; pedicels strongly winged, the apical up to 1 cm. long, the laterals .5–.6 cm. long; calyx-lobes obovate-oblong, up to .4 cm. long, .2 cm. broad, acute, obsoletely 3-nerved; corolla .8 cm. long, tube slightly less than one-half the length of the entire corolla; lobes ovate-oblong, subrotund; spurs slender, pendulous, incurved, one-half the length of the corolla.

Distribution: Peru.

No specimens examined, but description compiled from original publication and photographs. (TYPE, *Philippi*, BG, M.photo).

54. **H. Herzogii** Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 113. 1916.

Perennial caespitose herb, up to .5 dm. high; subterranean axis thick, black, branching, elongate, covered with blackened remains of leaf bases; stem curved-erect, scapiform, strongly winged, simple; basal leaves in dense rosette, thick, fleshy, attenuate into long petioles equalling the blades, spatulate or obovate-oblong to oblanceolate, up to 2.6 cm. long, .3 cm. broad, acute or more or less rounded at apex, obsoletely 3-nerved; cauline leaves 1–2 pairs, attenuate, but dilated at base and sessile, lanceolate to oblong-lanceolate, 1–2 cm. long, decreasing toward the summit, .25–.3 cm. broad, acute, obsoletely 3-nerved; inflorescence a small terminal 5-flowered subcapitate cyme; terminal pedicels 1 cm. long, lateral .5–.6 cm. long, strongly winged; calyx-lobes obovate-oblong to broadly oblanceolate, about .4 cm. long, less than .2 cm. broad, acute, obsoletely 3-nerved; corolla .6–.7 cm. long, tube about one-half the length of the entire corolla; lobes narrowly ovate, subrotund; spurs one-third to three-fourths the length of the corolla, pendulous, incurved; stamens about .15 cm. long, inserted at the orifice of the tube; filaments linear, anthers ovate; stigma truncate; capsule lanceolate.

Distribution: Bolivia.

Specimens examined:

BOLIVIA: Lagodos, alt. 4400 m., *Herzog 2377* (BG TYPE, M photo, V).

55. **H. silenoides** Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 113. 1916.

Halenia Dombeyana var. α Wedd., Chlor. And. **2**: 76. 1859, pp. non *Halenia gracilis* var. *Dombeyana* Griseb.

Perennial herb, for the most part less than 1.5 dm. high, seldom over 2 dm.; root thick, many branches; stems 1–6, simple, erect or very slightly decumbent, rather thick, covered with marcescent leaves at the bases; sterile stems short, densely leafy; basal leaves numerous, attenuate into long narrow petioles frequently equalling the blades, less than 2 cm. long, .35 cm. broad, acute, 3-nerved; cauline leaves 1–2 pairs, sessile, lanceolate, usually about 2 cm. long, acute, 3-nerved; inflorescence a terminal or axillary 3–10-flowered cyme, pedicels more or less erect, up to 2.5 cm. long; calyx-lobes oblong-oblanceolate, approximately .3–.5 cm. long, acute, uninerviate, densely reticulate; corolla approximately .9 cm. long, yellowish-green, tube about one-half the length of the entire corolla; spurs more than one-third the length of the corolla, slender, divergent, incurved at tips; stamens about .25 cm. long; filaments linear, anthers broadly ovate, acute; capsule up to 1.1 cm. long, narrowly ovate, attenuate at tip, subfalcate; seeds subglobose, reticulate.

Distribution: alpine meadows in Bolivia and Peru.

Specimens examined:

Bolivia: alpine meadows, Choquetanga Grande, alt. 3600 m., *Herzog 2402* (S); Unduavi, Nordyungas, 3300 m., *Buchtien 54* (F, G, NY); Unduavi, alt. 3300 m., *Buchtien 600* (US); Unduavi Valley, *Bro. Julio 338* (US); same locality, alt. 2000–2600 m., 1925, *Bro. Julio 455* (US); Pongo, alt. 4000 m., Feb. 17–March 1, 1926, *Tate 223* (NY); *Mandon 369* pp (BG type?).

Bolivia without Locality: *Cumming 128* (V).

Peru: Dept. of Cusco, Paso de Tres Cruces, Cerro de Cusilluyoc, alt. 3800–3900 m., May 3, 1925, *Pennell 13842* pp. (ANSP, US).

The specimen collected by *Tate* is rather doubtfully included. It has the habit of *silenoides,* but the flowers on the whole appear smaller, the spurs shorter and thicker, more like those of *Herzogii.* The specimens, *Pennell 13842*, found in the United States National Herbarium and the Philadelphia Academy of Natural Sciences, are certainly *H. silenoides,* but the same number located in the New York Botanical Garden Herbarium is *H. asclepiadea.*

56. H. umbellata (R. & P.) Gilg in Fedde, Rep. Spec. Nov. **2**: 53. 1906.

Swertia umbellata R. & P. Fl. Peruv. **3**: 21. *pl. 242, fig. b.* 1802.

Halenia Pavoniana G. Don, Gen. Hist. **4:** 177. 1838.

Halenia gracilis var. *β Dombeyana* Griseb. in DC. Prodr. **9:** 130. 1845.

Halenia Dombeyana Wedd. Chlor. And. **2:** 76. 1859.

Perennial herb up to 3 dm. high; root ligneous, frequently sending out short sterile densely leafy branches; stems 1–3, usually simple, erect, minutely striate, frequently branched above, the branches bearing inflorescences nearly as long as the terminal branch, marcescent leaves at base; basal leaves numerous, elliptic, attenuate into slender petioles nearly equalling blades, 2–3.5 cm. long, .6–.8 cm. broad, acute, 3-nerved; cauline leaves 2–3 pairs, attenuate into short petioles, or the extreme upper more or less sessile, lanceolate to elliptic, acute, 3-nerved; inflorescence terminal or axillary 5–14-flowered umbellate cymes, with an approach to a corymb; pedicels up to 3.5 cm. long, the center usually erect, the marginal more or less recurved and shorter; calyx-lobes obovate-elliptic, up to .6 cm. long, subacuminate, 3-nerved, reticulate at tip; corolla 1.0–1.3 cm. long, tube slightly less than half the length of the entire corolla; lobes ovate-oblong, acutish; spurs less than one-half the length of the corolla, very slender, tapering, slightly divergent; stamens .2–.25 cm. long; filaments linear, anthers broad-oblong, somewhat acute; stigma deeply cleft, slender, attenuate; capsule up to 1.5 cm. long, narrowly ovate-attenuate, subfalcate; seeds globose, reticulate.

Distribution: Andes of Peru.

Specimens examined:

Peru: Baños, *Dombey* (G, US); Agapata in Virgallis, coll. of 1854, *Lechler 2001* (DH, V); Lucumayo Valley, alt. 1800–3600 m., June 18, 1915, *Cook & Gilbert 1308* (US); Piñasniocj, Panticalla Pass, alt. 3600 m., July 14, 1915, *Cook & Gilbert 1811* (US); Mito, alt. 3000 m., July 8–22, 1922, *Macbride & Featherstone 1657* (F, M); La Quinua, alt. about 4000 m., May 14, 1922, *Macbride & Featherstone 2001* (F, M); Dept. of Cusco, Cerro de Colquipata, alt. 4100–4200 m., May 1, 1925, *Pennell 13738* (ANSP, NY, US); Dept. Puno, Prov. Sandia, alt. 2700 m., *Weberbauer 680* (DH).

Peru without Locality: *Pavon 567* (DH).

The illustration of *S. umbellata* in Ruiz & Pavon's 'Flora Peruvianae' has spurs longer than the specimens cited above but the plant is similar otherwise.

57. H. Meyeri Johannis Gilg in Engl. Bot. Jahrb. **54:** Beibl. 118, p. 114. 1916.

Perennial herb up to 2 dm. high, though usually less than 1.5 dm.; root ligneous; stem simple, erect, rather stout base frequently covered with marcescent leaves; basal leaves, when present, in dense rosette, attenuate into petiole longer than blade, narrowly elliptic, up to 2.2 cm. long, up to .6 cm. broad, acute, 3-nerved; 1–2 pairs of cauline leaves, sessile, elliptic, up to 1.8 cm. long, about .5 cm. broad, inconspicuosly 3-nerved, acute; inflorescence an axillary or terminal, 3–12-flowered cyme, loose or dense; pedicels up to 3 cm. long, usually recurved; calyx-lobes obovate-elliptic, papillate, approximately .6 cm. long, .2 cm. broad, 3-nerved, acute, reticulate; corolla up to 1.5 cm. long, yellowish, tube less than one-half the length of the entire corolla; lobes ovate-acute; spurs one-third to almost one-half the length of the corolla, rather thick, tapering, incurved; stamens about .5 cm. long; filaments linear, anthers ovate; capsule ovate, attenuate, about 1.5 cm. long.

Distribution: páramos of Ecuador.

Specimens examined:

Ecuador: Sangai, *Karsten* (V); Azuay, *Spruce 5131* (V); Quitensian Andes, coll. of 1855, *Couthouy* (F); Farm of Antesiana, Nov. 2, 1858, *Jameson* (ANSP); same locality, alt. 5000 m., Oct. 1923, *Anthony & Tate 299* (US); Rucu-Pichincha, Aug. 1923, *Anthony & Tate 182* (US); Prov. Carchi, páramos 12 miles west of Tulcán, alt. 3300 m., Aug. 10, 1923, *Hitchcock 20909* (G, NY, US); Chimborazo, *Hans Meyer 113* (BG type).

58. **H. barbicaulis** Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 112. 1916.

Annual herb, up to 2 dm. high; flowering stem seemingly erect, simple below, frequently branched above, branches erect, about .2 cm. thick, densely leafy, 4-alate, densely, long-ciliate below each node; internodes 2–4 cm. long; cauline leaves herbaceous, narrowed into broad ciliolate petioles, oblong, up to 2 cm. long, .5–.6 cm. broad, acute or very acute, subapiculate, 5-nerved, veins inconspicuous above, prominent beneath, loosely reticulate; inflorescence a terminal dense many-flowered (7–9) subumbellate cyme, or 3-flowered axillary cymes; pedicels of apical flowers 3–4 cm. long, lateral 2 cm. or less, all winged; calyx-lobes obovate-oblong, .6–.7 cm. long, .35–.4 cm. broad, apiculate, obsoletely 3-nerved; corolla about 1 cm. long, tube over one-third the length of the entire corolla; lobes ovate, subrotund, erose; spurs almost

one-half the length of the corolla, pendulous, divaricate; stamens .2–.3 cm. long; anthers ovate-oblong.

Distribution: Peru.

Specimens examined:

PERU: Chacapoyas, Dec. 1846, *Mathews* (DH TYPE).

59. **H. Rusbyi** Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 117. 1916.

Perennial herb up to 3 dm. high; root strong, thick, ligneous, frequently horizontal, curved at the apex, sending up one or more simple erect flowering stems, bearing marcescent leaves at the base, or short densely leafy sterile branches; basal leaves slightly narrowed into broad petioles as long as the leaf blades, elliptic, frequently up to 3 cm. long, acute, 3-nerved; cauline leaves 1–4 pairs, becoming sessile toward the summit of the stem, up to 3 cm. long, oblong-lanceolate, attenuate, acuminate; inflorescence terminal and axillary many-flowered umbelliform cymes; pedicels erect, up to 2 cm. long; calyx-lobes narrowly ovate, up to .7 cm. long, acute, 3-nerved; corolla up to 1.4 cm. long, tube .25–.3 cm. long; lobes ovate, acute; spurs approximately one-half or slightly more than one-half the length of the corolla, almost horizontally divergent, often with the tips incurved; stamens about .35 cm. long; filaments linear, anthers broadly ovate; capsule up to 1.5 cm. long, ovate-lanceolate, subfalcate; seeds ovoid.

Distribution: Bolivia.

Specimens examined:

BOLIVIA: Unduavi, alt. 3300 m., Oct. 1885, *Rusby 670* (ANSP, G, M, NY, US, V TYPE).

Similar to *H. Purdieana*, but a sturdier plant with broader flowers, spurs more divergent and more strongly recurved at tip, stem thicker, and leaves larger.

60. **H. Purdieana** Wedd. Chlor. And. **2**: 76. *pl. 53 A*. 1859.

Perennial herb, up to 2.5 dm. high; root ligneous; sterile stems 1–3, short, leafy; fertile stems probably more than one, simple, erect, slender; basal leaves in dense rosette, attenuate into slender petioles nearly equalling the blades in length, lanceolate to linear, up to 1.5 cm. long, .3 cm. broad, acute, obscurely 3-nerved, mid-vein prominent; cauline leaves 3–5 pairs, at intervals of about 4 cm., more or less closely appressed, practically sessile, linear,

attenuate, 2 cm. or less long, acuminate; inflorescence a terminal, rarely axillary as well, 1–5-flowered cyme; pedicels up to 2.5 cm. long, recurving conspicuously at tip; calyx-lobes lanceolate, up to .7 cm. long, attenuately acuminate, 3-nerved; corolla up to 1.8 cm. long, greenish-white (fide *Killip & Smith 18665*, corolla-tube and lobes greenish-white, spurs white; *Linden 729*, fl: blanches), tube less than one-third the length of the entire corolla; lobes ovate, acute, erose; spurs nearly one-half the length of the corolla, slender, tapering, divergent, but slightly depressed at tip; capsule approximately 1.4 cm. long, ovate, attenuate at tip.

Distribution: Colombia.

Specimens examined:

COLOMBIA: Prov. de Pamplona, Páramo de las Cruces, alt. 3000 m., Nov. 1842, *Linden 729* pp. (BG TYPE, DH, M photo, V); "Dept. Norte de Santander: between Mutiscua and Pamplona," alt. 3400 m., Feb. 23, 1927, *Killip & Smith 19723* (US); "Dept. Norte de Santander: Páramo de Romeral," alt. 3800–4200 m., Jan. 30, 1927, *Killip & Smith 18665* (US); "Dept. Santander: Páramo de las Puentes," above La Baja, alt. 3500–3700 m., Jan. 25, 1927, *Killip & Smith 18229* (US); "Dept. Santander: Páramo de Romeral," alt. 3800–4000 m., Jan. 29–30, 1927, *Killip & Smith 18546* (NY, US); same locality, 3800–4200 m., Jan. 30, 1927, *Killip & Smith 18644* (US); same locality and date, *Killip & Smith 18688* (US); Páramo de las Coloradas, above La Baja, alt. 3900–4100 m., Jan. 27, 1927, *Killip & Smith 18426* (M, NY, US); same locality and date, *Killip & Smith 18466* (NY, US); western slope of Páramo Rico, alt. 3600 m., Jan. 15–19, 1927, *Killip & Smith 17722* (US).

The majority of the specimens collected by *Killip & Smith* vary from the typical members of the species only in that the spurs are slightly more pendulous. The habit is similar. This difference is not considered of varietal importance, hence the specimens are placed in the species proper. The species *H. Purdieana* has a marked resemblance in habit and in the color of the flower to *H. Pringlei* of Mexico, but the spurs are not reflexed to the extent they are in the former.

60a. H. Purdieana var. **congesta**[65] Allen, n. var.

Plant shorter than the species, not more than 1 dm., usually less than .5 dm., high; root heavy, extremely ligneous; stems 1–

[65] **H. Purdieana var. congesta** Allen, var. nov.—Planta speciei breviora, non plusquam 1 dm. alta, plerumque minusquam .5 dm. alta; radice crassa, lignissima; caulibus 1-multis, erectis, simplicibus; foliis basalibus speciei pluribus, in rosula densissima, subcoriaceis, linearibus vel lineari-lanceolatis, minusquam 1.5 cm. longis; foliis caulinis 1–2 geminis, lineari-lanceolatis, adpressis; inflorescentia speciei simili.—COLOMBIA: Dept. Santander, Páramo de Santurbán, near Vetas, alt. 3950–4160 m., Jan. 17, 1927, *Killip & Smith 17568* (M TYPE, NY, US).

many, erect, simple; basal leaves more numerous than in the species, and in very dense rosettes, subcoriaceous, linear to linear-lanceolate, less than 1.5 cm. long; cauline leaves 1–2 pairs, linear-lanceolate, very closely appressed; inflorescence similar to that of species.

Distribution: known only from the Dept. of Santander, Colombia.

Specimens examined:

COLOMBIA: "Dept. Santander: Páramo de Santurbán," near Vetas, alt. 3950–4160 m., Jan. 17, 1927, *Killip & Smith 17568* (M TYPE, NY, US); same locality and date, *Killip & Smith 17485* (NY, US); Páramo Frailejonale, near Vetas, alt. 3750–3850 m., Jan. 21, 1927, *Killip & Smith 17982* (NY, US); Páramo de Mogotocoro, near Vetas, alt. 3700–3800 m., Jan. 18, 1927, *Killip & Smith 17604* (NY, US); Páramo Rico, near Vetas, alt. 3750–3850 m., Jan. 18, 1927, *Killip & Smith 17662* (M, NY, US); Páramo de las Vegas, alt. 3700–3800 m., Dec. 20–21, 1926, *Killip & Smith 15680* (US); Páramo de Santurbán, en route from Tona to Mutiscua, alt. 3800–4300 m., Feb. 18, 1927, *Killip & Smith 19551* (US).

61. H. **Hieronymi** Gilg in Fedde, Rep. Spec. Nov. **2**: 52. 1906.

Annual, up to 3.5 dm. high; stem single, simple, erect; basal leaves few, in a rather loose rosette, petiolate, oblanceolate, up to 2.5 cm. long, .25 cm. broad; cauline leaves 4–5 pairs, membranaceous, sessile, lanceolate, 1.5–5 cm. long, .3–.9 cm. broad, acute, obsoletely 3-nerved; inflorescence a terminal 5–6-flowered subumbelliform cyme, or often solitary axillary flowers, pedicels up to .7 cm. long; calyx-lobes oblanceolate, .6–.7 cm. long, .2 cm. broad, acute; corolla about 1 cm. long, yellow-green; lobes ovate, acute; spurs nearly one-half the length of the corolla, pendulous, slightly spreading.

Distribution: Argentina.

No specimens examined, but description compiled from original publication and photograph. (TYPE, *Fiebrig 2645*, BG).

62. H. **bifida**[66] Rusby & Allen, n. sp.

Perennial, up to 3 dm. high; root thick, ligneous; stem single, simple, erect, rather stiff, stout, winged; basal leaves in a dense

[66] **H. bifida** Rusby & Allen, sp. nov.—Herba perennis, usque ad 3 dm. alta; radice crassa, lignea; caule solitario, simplice, erecto, paulo rigido, robusto, alato; foliis basalibus, in rosula densa, rigidis, petiolatis, oblanceolatis, usque ad 4.5 cm. longis, .4 cm. latis, acutis vel subito acuminatis, 3-nerviis; foliis caulinis 3–4 geminis, sessilibus, lanceolatis, 2–3 cm. longis, decrescentibus sursum, .3 cm. latis, acuminatis, 3-nerviis, medio-nervo infra prominenti, supra immerso; inflorescentia multo-flor-

rosette, stiff, petiolate, oblanceolate, up to 4.5 cm. long, .4 cm. broad, acute to abruptly acuminate, 3-nerved; cauline leaves 3–4 pairs, sessile, lanceolate, 2–3 cm. long, decreasing toward the summit, .3 cm. broad, acuminate, 3-nerved, midvein prominent below, sunken above; inflorescence a many-flowered terminal subumbellate cyme, frequently fewer-flowered cymes in axils of upper leaves; pedicels up to 3 cm. long; calyx-lobes broadly oblanceolate, .5 cm. long, .15 cm. broad, acute, obsoletely 3-nerved; corolla up to 1.3 cm. long, tube one-third the length of the entire corolla; lobes ovate, more or less acute, apiculate, erose; spurs more than ½ the length of the entire corolla, slender, tapering, pendulous, spreading, incurved at tip; stamens .25 cm. long; filaments linear; seeds ovoid, dark brown.

Distribution: Bolivia.

Specimens examined:

Bolivia: Cocopunco, alt. about 3000 m., March 24–30, 1926, *Tate 379* (NY type).

63. **H. Weddelliana** Gilg in Engl. Bot. Jahrb. **25**: 724. 1898; **54**: Beibl. 118, p. 118. 1916.

H. antigonorrhoica Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 119. 1916.

Perennial herb from 1.5–3 dm. high; root fibrous; subterranean stem more or less elongate, densely covered with remains of marcescent leaves, horizontal, more or less erect, many-stemmed; sterile stems leafy, numerous; flowering stems numerous, curved or erect, the lower part densely leafy, the upper loosely leafy, internodes 2–8 cm. long; basal leaves numerous, in rosette, narrowly petiolate, subconnate, spatulate to oblong-lanceolate, 1–3 (rarely 5) cm. long, .2–.6 cm. broad, acute, 3-nerved; cauline leaves subconnate, lanceolate to oblong-lanceolate, 1–2 (rarely 6) cm. long, .2–.6 cm. broad, acute, 3-nerved; inflorescence usually terminal, occasionally lateral, subumbellate or subcapitate many-

---

ifera, terminali, subumbellato-cymosa; saepe cymis pauciore-floriferis in superiorum foliorum axibus; pedicellis usque ad 3 cm. longis; calycis lobis late oblanceolatis, acutis, obsolete 3-nerviis, ca. .5 cm. longis, .15 cm. latis; corolla usque ad 1.3 cm. longa; tubo ⅓ totae corollae longitudini adaequanti; lobis ovatis, plusminusve acutis, apiculatis, erosis; calcaribus tenuibus, plusquam ½ totae corollae longitudini adaequanti, attenuatis, pendulis, divaricatis, ad apicem incurvatis; staminibus .25 cm. longis; filamentis linearibus; seminibus ovoideis, brunneis.—Bolivia: Cocopunco, alt. about 3000 m., March 24–30, 1926, *Tate 379* (NY type).

flowered cymes; pedicels .3–.8 cm. long, the central one longer; calyx-lobes obovate-oblong to oblong, .5–.8 cm. long, acuminate or acute, obsoletely 3-nerved; corolla 1.2–1.5 cm. long, yellow-green, tube less than one-half the length of the entire corolla; lobes ovate, acute to subrotund, entire or crenulate, erose; spurs one-half (rarely three-fourths) the length of the corolla, subhorizontally divaricate but incurved at the apex; stamens .25–.35 cm. long; filaments linear usually, anthers ovate; capsule lanceolate-ovate.

Distribution: mountains of Colombia, Ecuador, and Peru.

Specimens examined:

COLOMBIA: near Pasto, alt. 3600 m., June 13, 1878, *Lehmann* (V); páramos of Guanacas, Prov. Popayan, *Lehmann 809* (NY); same locality, *Lehmann 6128* (BG TYPE, F, US); same locality, *Hartweg 1255* (NY, V TYPE of *H. antigonorrhoica* Gilg); grassy páramo, Paletara, Dept. of Cauca, June 15–17, 1922, *Pennell 6929* (ANSP, G, NY, US); same locality, alt. 2950 m., 1884, *Lehmann 3498* (US).

ECUADOR: Andes, Quito, alt. 4000 m., April 1864, *Jameson* (V); pasture of the Andes, alt. 4000 m., March 1859, *Jameson* (NY, US, V); 1859, *Jameson* (BG G, M photo, UC); without locality or date, *Jameson* (NY, US); Quitian Andes, *Jameson* (V); Andes, Quito, 1855, *Couthouy* (ANSP, G, NY); same locality, 1857–9, *Spruce 5131* (G, UC, V); San Ignacio, Pichincha Region, alt. approximately 4000 m., Aug. 14–19, 1923, *Anthony & Tate 133* (US); Pichincha, alt. 3500 m., Feb. 3, 1927, *Firmin 5* (US); Pichincha-Quito, *Karsten* (V); same locality, Dec. 30, 1929, *Heilborn 137* (S); Tunguragua, above Baños, alt. 2000 m., Feb. 27, 1920, *Holmgren 378* (S); Cotopaxi, alt. 3000–4000 m., Dec. 27, 1879, *Lehmann* (V); without locality, *Gesner* (UC); Mt. Chimborazo, alt. 4200 m., *Rimbach 154* (US, M); "in pascuis andinis, alt. 2800–4000 m.," *Sodiro 109* (BG, TYPE of *H. Weddelliana* Gilg).

PERU: grassy places in shrub-wood, Putis, Choimacota Valley, Prov. Huanta, Dept. Ayacucho, alt. 3400–3500 m., Feb. 27–March 12, 1926, *Weberbauer 7524* (F); Tambo de Vaca, alt. about 4000 m., June 10–24, 1923, *Macbride 4362* (F, M).

64. H. elegans[67] Allen, n. sp.

Stout perennial, up to 4 dm. high; root thick, fibrous; axis covered with blackened remains of leaf bases, erect, sometimes

[67] **H. elegans** Allen, sp. nov.—Herba perennis, usque ad 4 dm. alta; radice crassa, fibrata; axe foliorum reliquiis tecto, erecto, saepe plus minusve decumbenti; ramis brevibus sterilibus, dense foliosis, 10–12 cm. altis; caule solitario, florifero, crasso, .5–.6 cm. in diametro, infra simplice, supra parum ramoso, striato; foliis basalibus in rosula densa, petiolatis, late lanceolatis, 7–9 cm. longis, acuminatis, prominenti 3-nerviis, nervis supra immersis, infra prominenti; foliis caulinis 4–6 geminis, sessilibus, 2–4 cm. longis, sursum decrescentibus; inflorescentia cymosa, laxa, multoflorifera, terminali vel ramis brevibus clause adpressis terminatis, laxis spicis similibus; pedicellis usque ad 4 cm. longis, ad apicem parum curvatis; calycis lobis foliosis, late lanceolato-ellipticis vel ovatis, 1–1.2 cm. longis, .4 cm. latis, attenuate acuminatis, prominenti 3-nerviis; corolla 3–4 cm. longa, viride, tubo ⅙–¼ corollae longitudini adaequanti; lobis obovato-ovatis, erosis, apiculatis; calcaribus prope ½

more or less decumbent; short sterile branches, densely leafy, 10–12 cm. high; single flowering stem, coarse, .5–.6 cm. in diameter, simple below, slightly branched above, striate; basal leaves in dense rosettes, petiolate, broadly lanceolate, 7–9 cm. long, acuminate, prominently 3-nerved, nerves sunken above, prominent below; cauline leaves 4–6 pairs, sessile, 2–4 cm. long, decreasing toward the summit; inflorescence loose, many-flowered, terminal cymes, or cymes terminating the short, closely appressed branches, giving the inflorescence a loose, spike-like appearance; pedicels up to 4 cm. long, slightly curved at the tip; calyx-lobes foliaceous, broadly lanceolate-elliptic or ovate, 1–1.2 cm. long, .4 cm. broad, attenuate-acuminate, prominently 3-nerved; corolla 3–4 cm. long, green, tube one-sixth to one-fourth the length of the entire corolla; lobes obovate-ovate, erose, apiculate; spurs nearly one-half the length of the corolla, slender, with tips extremely glandular, pendulous, curved outward, somewhat spreading, approximate at base; stamens about 1 cm. long; filaments linear, anthers narrowly ovate; capsule attenuate-ovate.

Distribution: Colombia.

Specimens examined:

Colombia: Dept. Santander, Páramo de Romeral, alt. 3800–4100 m., Jan. 29–30, 1927, *Killip & Smith 18568* (M type, NY, US).

65. **H. Hoppii** Reimers in Engl. Bot. Jahrb. **62**: 335. 1929.

Perennial about 1 dm. high; flowering stem simple, erect, rather stout; basal leaves in a dense rosette, herbaceous, petiolate, oblanceolate, 3 cm. long, .4 cm. broad, acute, nerved; cauline leaves 1–2 pairs, similar to a rosette, but petioles shorter; inflorescence a terminal, many-flowered cyme; pedicels 1–3 cm. or more long; calyx-lobes ligulate to elliptic, .6 cm. long, .2 cm. broad, acute at apex, subapiculate, obsoletely 3-nerved; corolla 1 cm. or less long, yellow-green, tube about one-third the length of the entire corolla; lobes acutish ovate, subrotund; spurs very slender, one-third to one-half the length of the corolla, pendulous, divergent at apex; stamens .35 cm. long.

---

corollae longitudini adaequanti, tenuibus, ad apicem glandulosis, pendulis, curvatis extrinsecis divergentioribus ad basin approximatis; staminibus ca. 1 cm. longis; filamentis linearibus; antheris attenuate ovatis; capsula attenuata-ovata.—Colombia: Dept. Santander, páramo de Romeral, alt. 3800–4100 m., Jan. 29–30, 1927, *Killip & Smith 18568* (M type, NY, US).

Distribution: Colombia and Peru.
Specimens examined:
COLOMBIA: (TYPE not seen, *Hopp 33a* BG, M photo).
PERU: Cuzco, alt. 3000–3600 m., July 1923, *Herrera* (US).

66. **H. asclepiadea** (HBK.) G. Don, Gen. Hist. 4: 177. 1838; Griseb. Gen. & Sp. Gent. 326. 1839; in DC. Prodr. 9: 129. 1845 pp; in Linnaea 22: 45. 1849; Benth. Pl. Hartw. 228. 1846; Wedd. Chlor. And. 2: 75. 1859, pp.

Swertia asclepiadea HBK. Nov. Gen. & Sp. Pl. 3: 175. 1818.

S. quadricornis Willd. ex Roem. & Schult. Syst. Veg. 6: 134. 1820; fide Gilg, *l. c.*

Perennial herb, up to 4 dm. high; fertile stems one or more, simple, erect; one to several short densely leafy sterile stems arising from the root or, rarely, from the base of a flowering stem; basal leaves attenuate into a more or less slender elongate petiole, narrowly lanceolate, 3–4 cm. long, up to .5 cm. broad, attenuate-acuminate, 3-nerved; cauline leaves sessile, more elongate than the basal leaves but otherwise similar to them; inflorescence a terminal or axillary, 3–8-flowered, occasionally umbelliform cyme, petioles up to 3.5 cm. long; calyx-lobes broadly lanceolate, up to .6 cm. long, acute, 3-nerved; corolla approximately 1.2–1.3 cm. long, greenish-yellow, tube one-fourth the length of the entire corolla; lobes broadly ovate, acute; spurs horizontal, measuring up to 1.7 cm. from tip to tip; stamens approximately .45 cm. long; filaments linear, anthers ovate; capsule up to 1.8 cm. long, ovate, attenuate at tip, subfalcate; seeds oval-elliptic, reticulate.

Distribution: Colombia, Ecuador, and Peru.
Specimens examined:

COLOMBIA: Dept. of Cundinamarca, above Bogota, bushy slope, alt. 2700–2800 m., Aug. 16, 1917, *Rusby & Pennell 1269* (NY); Páramo de Guasca, July 21, 1919, *Bro. Ariste-Joseph A390* (US); mountains near Bogota, Oct. 20, 1852, *Holton 468* (ANSP, DH, G, NY); páramos, Bogota, March 1916, *M. T. Daire 123* (US); Bogota, alt. 2900 m., *Karsten* (V); Bogota, alt. 3000 m., 1851–57, *Triana 1958* (V); near Bogota, *Goudot* (DH); Andes near Bogota, 1843, *Hartweg 1254* (DH, NY, V); same locality, *Bro. Ariste-Joseph* (US); Pamplona, Páramo de las Cruces, alt. 3600 m., Nov. 1842, *Linden 729* pp. (DH, V); Tequendama, 1917, *Bro. Ariste-Joseph A46* (G, US); páramos, Guasca, alt. 4000 m., Aug. 1931, *Arbelaez 1201* (US); (TYPE not seen, *Humboldt & Bonpland*, HJP, M, photo).

ECUADOR: Prov. Loja, between San Lucas and Oña, alt. 2200–3100 m., Sept. 7, 1923, *Hitchcock 21539* (G, NY, US).

PERU: Dept. of Cusco, Paso de Tres Cruces, Cerro de Cusilluyoc, alt. 3800–3900 m., May 3, 1925, *Pennell 13842* pp. (NY).

This species is closely related to *H. recurva* of southwestern United States and Mexico.

67. **H. Kalbreyeri** Gilg in Engl. Bot. Jahrb. **54:** Beibl. 118, p. 120. 1916.

Perennial caespitose herb up to 2.5–4 dm. high; axis procumbent, slender, subligneous, the upper part erect; stems 1–several, erect, more or less slender, simple, internodes 3.5 cm. long; sterile stems up to 7–8 cm. high, densely leafy above; rosette leaves petiolate, herbaceous, stiffly erect, never drooping, oblanceolate, about 5 cm. long, .3 cm. broad, acute, 3-nerved, midvein heavy and hard; cauline leaves often as many as 8 pairs, sessile, linear-lanceolate to lanceolate, up to 2.5 cm. long, .2–.25 cm. broad, acute, 3-nerved; inflorescence terminal or axillary cymes, 1–5-flowered, frequently pseudo-spicate or pseudo-paniculate, pedicels up to 3 cm. long; calyx-lobes lanceolate, up to .5 cm. long, .15 cm. broad, 3-nerved; corolla 1.2–1.5 cm. long; tube one-third the length of the entire corolla; lobes ovate, somewhat acute, erose; spurs one-half to three-fourths the length of the corolla; stamens about .4 cm. long; filaments linear, anthers broadly ovate; capsule lanceolate.

Distribution: Colombia.

Specimens examined:

Colombia: Páramo de Choavhi, near Bogota, alt. 3700 m., Aug. 8, 1922, *Killip & Bro. Ariste-Joseph 11924* (ANSP, US); Dept. Cusco, La Raya, April 22, 1925, *Pennell 13513* (ANSP); Dept. Norte de Santander, between Mutiscua and Pamplona, alt. 3400 m., Feb. 23, 1927, *Killip & Smith 19723* (US). (type not seen, *Kalbreyer 717*, BG, M photo).

68. **H. bella** Gilg in Fedde, Rep. Spec. Nov. **2:** 52. 1906.

Perennial herb, 2–2.5 dm. high; stems decumbent, bearing at apex numerous short sterile leafy branches up to 10 cm. long, and elongate fertile branches, simple, erect, more or less slender, internodes up to 6 cm. long; basal leaves numerous, subcoriaceous, petiolate, oblanceolate to lanceolate, 3–3.5 cm. long, .4 cm. broad, acute, 3–5-nerved, veins sunken above, prominent below; leaves of sterile branches lanceolate, acute; cauline leaves 3–4 pairs, sessile, lanceolate, acute; inflorescence a terminal sub-umbelliform many-flowered cyme, rarely axillary 3-flowered cymes; calyx-lobes obovate-lanceolate, .6–.7 cm. long, .2 cm.

broad, acute, nerved; corolla approximately 1.6 cm. long, green; lobes obovate, acute; spurs horizontal or subhorizontal, about three-fourths the length of the corolla.

Distribution: Peru.

Specimens examined:

PERU: Dept. Junín, Prov. Tarma, Huacapistana, alt. 3000–3100 m., *Weberbauer 2065* (BG TYPE, DH, M photo); *Pavon 737* (DH).

69. **H. sphagnicola** Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 121. 1916.

Perennial, about 2.5 dm. high; root slender, multifibrous; axis short, slender, nearly erect; several curved-ascending sterile branches; fertile branches single, simple or branched at base, erect, the lower portion densely leafy, the upper loosely leafy; basal leaves in rosette, herbaceous, attenuate into petioles once or twice the length of the blades, obovate, 1.5–2.2 cm. long, .5 cm. broad; lower cauline leaves several pairs, petiolate, obovate, 1.5–2 cm. long, .3 cm. broad, acute; upper cauline leaves slightly narrowed at base but more or less sessile, oblong or oblong-lanceolate, .7–1.2 cm. long, .2–.25 cm. broad, acute to acuminate, obsoletely 3-nerved; inflorescence a terminal many-flowered subglobose cyme; pedicels about 1–1.3 cm. long; calyx-lobes obovate to ovobate-oblong, scarcely .3 cm. long, .1–.15 cm. broad, subrotund at apex, obsoletely 3-nerved; corolla .8–.9 cm. long, sulphur-yellow, tube less than one-half the length of the entire corolla; lobes ovate, rotund; spurs slender, tapering, one-half the length of the corolla, but subhorizontally divaricate, often curved upward at the apex.

Distribution: Peru.

No specimens examined, but description compiled from original publication and photograph. (TYPE, *Weberbauer 4376*, BG, M, photo).

List of Exsiccatae

The distribution numbers are printed in *italics*. Unnumbered collections are indicated by a dash. The numbers in parentheses are the species numbers used in this monograph.

Aiton, G. B. — (23).
Alaman, L. — (2a).
Allen, J. A. — (23).
Altamirano, F. *908* (21).
Andrieux, G. *226* (31).
Anthony, H. E. & Tate, G. H. H. *133* (63); *182*, *299* (57).
Arbelaes, E. P. *1201* (66).

Archer, W. A. *1348* (2).
Ariste-Joseph, Bro. —, *A46* (66); *A423* (10); *A390* (66).
Arnold, I. S. — (23).
Arsène, Bro. G. — (2a); — (2d); — (31a); *37* (23); *55* (2d); *1703*, *1711* (2a); *2098* (2); *5610* (2a); *5864*, *5957* (2d).
Bailey, W. W. — (23).
Bang, M. *665* (45); *1019* (48).
Banks, J. — (23); — (23a).
Bergman, H. F. *2948* (23).
Berlandier, J. L. *1207* (2, 2a).
Beyrich, H. K. — (2a).
Blake, J. — (23).
Blumer, J. C. *1359* (22).
Boott, W. — (23).
Bourgeau, E. — (23); *799*, *3126* (2a).
Bowdoin College, *290* (23a).
Boyce, T. E. — (23).
Brenton, M. E.— (23); *144a?* (23a).
Brinkman, A. H. *3678* (23).
Brown, S. *667* (23).
Buchtien, O. *54*, *600* (55); *1484* (35).
Burglehaus, F.— (23).
Canby, W. M. — (23).
Chapman, A. W. — (23).
Churchill, J. R. — (23).
Chute, A. P. — (23).
Collins, J. F., Fernald, M. L. & Pease, A.S. —, *4261* (23).
Conzatti, C. *2295*, *4265* (26).
Conzatti, C. & Gonzalez, V. *378* (2b).
Cook, O. F. *45* (32a).
Cook, O. F. & Gilbert, G. B. *1308* (56); *1793* (36); *1811* (56).
Coulter, T. *939* (31).
Couthouy, J. P. — (51); — (57); — (63).
Cristan, F. — (24).
Cumming, H. *128* (55).
Daire, M. T. *123* (66).
Dodge, C. K. *352* (23).
Dombey, J. — (56).
Don, D. — (31).
Drexter, C. — (23).
Drummond, J. — (23).
Eames, E. A. — (23).
Eames, E. H. & Godfrey, C. C. *8030* (23a).
Eggleston, W. W. —, *3051* (23); *10774*, *15781*, *17137* (22).
Eggleston, W. W. & Fernald, M. L. — (23).
Ehrenberg, K. *608* (30).
Ellis, C. C. *20* (22).
Endlich, R. *53* (22).
Farr, E. M. — (23).
Farwell, O. A. *249*, *770* (23).
Faxon, C. E. — (23).
Fellows, D. W. — (23).
Fernald, M. L. —, *87*, *1151* (23).
Fernald, M. L. & Collins, J. F. *244* (23).
Fernald, M. L., Dodge, C. W. & Smith, L. B. *25986* (23).
Fernald, M. L. & Long, B. *14390*, *14392* (23); *28950* (23a).
Fernald, M. L., Long, B. & Dunbar, B. H. *26982*, *26983*, *26984*, *26985*, *26986* (23a).
Fernald, M. L., Long, B. & Fogg, J. M. *381*, *382* (23a).
Fernald, M. L. & Pease, A. S. *16624* (23).
Fernald, M. L. & Wiegand, K. M. *3908*, *3909*, *6081* (23a).
Fernald, M. L., Wiegand, K. M. & Kittredge, J. *3910* (23a); *3911* (23); *3912* (23a).
Fernald, M. L., Wiegand, K. M. & Long, B. *28951* (23a).
Firmin, Fr. G. *5* (63); *697* (42).
Forbes, F. F. — (23).
Fowler, J. — (23).
Franklin & Douglas — (23).
Friedrichstahl, E. — (24).
Funck, N. *415* (15).
Funck, N. & Schlim, L. J. *901* (7); *1148* (8).
Galeotti, H. *1488* (30); *1489* (26); *1490* (2b); *7166* (33); *7219* (2); *7220* (30); *7221* (1); *7222* (31).
Garcia, P. Ibana — *410* (25).
Gates, F. C. *14156* (23).
Gates, F. C. & M. T. *9768*, *10716* (23).
Gehriger, W. *92a* (8).
Gesner, — (63).
Ghiesbreght, A. *137*, *618* (2).
Goderiels, — (23).
Goodale, G. L. — (23).

Goudot, — (10); — (66).
Greenman, J. M. & M. T. *5994* (24b).
Grisebach, A. H. R. — (2); — (23).
Gutzwiller, *32* (18).
Haberer, J. V. —, *601* (23).
Hadley, J. *1* (23).
Hall, C. H. — (23).
Hallowell, S. M. — (23).
Harper, E. T. — (23).
Harshberger, J. W. *137* (2a, 30).
Hartweg, T. *210* (2b); *347* (31a); *494* (33); *1254* (66); *1255* (63).
Hasse, H. E. — (23).
Hay, G. U. — (23).
Haydon, W. — (23).
Heilborn, O. *137* (63); *437* (42).
Heinburger, — (23).
Heller, A. A. *391* (31a); *401* (2).
Herrera, F. L. — (65).
Herzog, T. *2377* (54); *2402* (55).
Heyde, E. T. & Lux, E. *4729* (34).
Hill, E. J. *179* (23).
Hitchcock, A. S. *20909* (57); *21539* (66).
Hoffmann, C. *119* (24b).
Holmgren, I. *378* (63).
Holton, I. F. *19* (*464*) (2); *467* (10); *468* (66).
Holway, E. D. W. — (23).
Hooker, J. D. — (23).
Hosford, F. H. — (23).
Houghton, D. *34* (23).
House, H. D. *5643*, *15688* (23).
Howe, C. D. — (23a).
Howe, C. D. & Lang, W. F. *1298*, *1403* (23a).
Humboldt, A. & Bonpland, A. — (2); — (31); — (42).
Hyatt, A., Shaler, N. & Verrill, A. E. — (23).
Jahn, A. *558*, *839* (7).
Jameson, W. — (2); *53* (40); — (42); — (49); — (57); — (63).
Jones, M. E. — (2e); — (25); —, *28603* (22).
Julio, Bro. *338*, *455* (55).
Jurgensen, *386* (33); *812* (26); *811* (30).
Kalenborn, A. S. *91* (38).
Kalenborn, M. 91 (38).
Karsten, H. — (5); — (10); — (42); — (57); — (63); — (66).
Karwinsky, W. F. von, *122* (31).
Kennedy, G. G. — (23).
Kennedy, Mrs. J. J. *38* (23).
Killip, E. P. *6889* (2).
Killip, E. P. & Ariste-Joseph, Bro. *11924* (67).
Killip, E. P. & Smith, A. C. *15679* (3); *15680*, *17485* (60a); *17516*, *17521*, *17566* (50); *17568*, *17604*, *17662* (60a); *17722* (60); *17982* (60a); *18229*, *18426*, *18466*, *18546* (60); *18568* (64); *18644*, *18665*, *18688* (60); *19551* (60a); *19723* (60, 67); *21737* (44); *22083*, *22087* (43).
Kittredge, E. M. — (23).
Kofoid, C. A. — (23).
Kuntze, O. *2356* (24); *23783* (2).
Lange, J. — (23).
Lankester, C. H. *670* (24).
Lechler, W. *2001* (56).
Lehmann, F. C. — (66); *809*, *3498* (63); *4878* (49); *6128* (63); *6190* (12); *7860* (17).
Lemmon, J. G. — (2a); — (22).
Lemmon, J. G. & wife — (2a); — (22).
Leston, — (23).
Liebmann, F. M. *10770* (33); *10771* (26); *10774* (30); *10775* (2); *10776* (30); *10777* (2c); *10778* (2); *10780* (31).
Linden, J. *437* (6); *456* (2); *729* (60); *729* (66); *934* (1); *935* (31a).
Loew, O. — (22).
Loring, — (23a); — (23).
Louis-Arsène, Fr. *365*, *403* (23a).
Lour, O. — (22).
Macbride, J. F. *3040* (47); *3072* (36); *3431* (2); *4362* (63).
Macbride, J. F. & Featherstone, *898* (38); *1657*, *2001* (56).
Macfarlane, — (23).
Mackenzie, K. K. *3618* (23).
Mackenzie, K. K. & Griscom, L. *10411*, *11135* (23a).
MacNab, W. — (23).
Macoun, J. —, *77*, *300*, *1191*, *54300 ?*, *68734 ?* (23).
Mandon, G. *369* (36, 52); *369* (56).

Index to Species

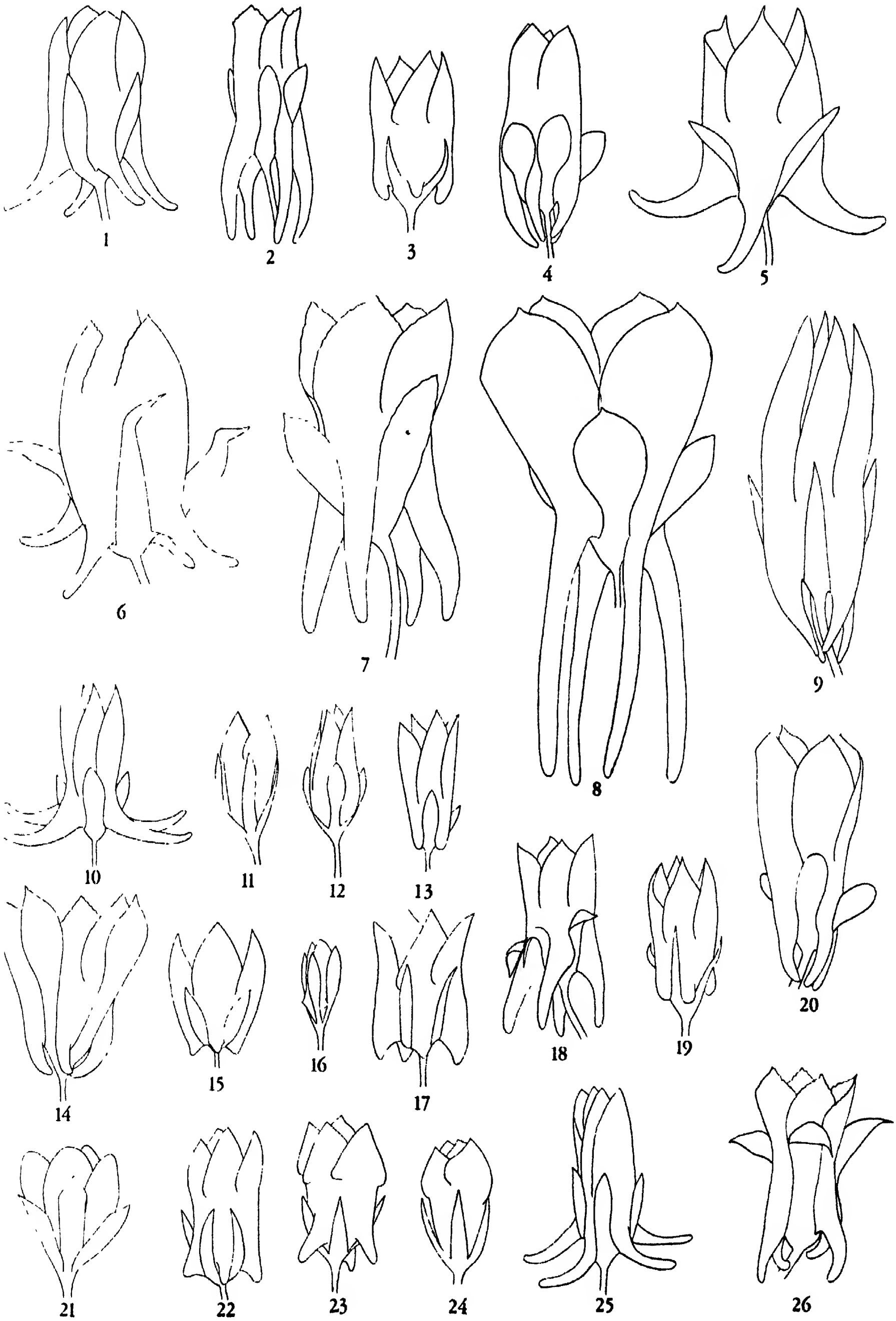
New genera, species, varieties, and combinations are printed in **bold face** type; synonyms in *italics*, and previously published names in ordinary type.

Explanation of Plate

PLATE 8

Camera-lucida drawings of the flower of the following species of *Halenia*. × 2.

Fig. 1. *H. deflexa* (Sm.) Griseb. (spurred form).
Fig. 2. *H. decumbens* Benth.
Fig. 3. *H. brevicornis* (HBK.) Don var. *multiflora* (Benth.) Allen.
Fig. 4. *H. Conzattii* Greenm.
Fig. 5. *H. recurva* (Sm.) Allen.
Fig. 6. *H. rhyacophila* Allen.
Fig. 7. *H. Shannonii* Briq.
Fig. 8. *H. guatemalensis* Loesener.
Fig. 9. *H. Palmeri* Gray.
Fig. 10. *H. Pringlei* Rob. & Seat. (spurred form).
Fig. 11. *H. brevicornis* (HBK.) Don.
Fig. 12. *H. Pringlei* Rob. & Seat. (non-spurred form).
Fig. 13. *H. nudicaulis* Mart. & Gal.
Fig. 14. *H. platyphylla* Allen.
Fig. 15. *H. brevicornis* (HBK.) Don var. *latifolia* (Schl. & Cham.) Allen.
Fig. 16. *H. deflexa* (Sm.) Griseb. (non-spurred form).
Fig. 17. *H. brevicornis* (HBK.) Don var. *divergens* Allen.
Fig. 18. *H. Schiedeana* (Schl. & Cham.) Griseb.
Fig. 19. *H. brevicornis* (HBK.) Don var. *chihuahuensis* Allen.
Fig. 20. *H. plantaginea* (HBK.) Griseb.
Fig. 21. *H. alata* (Mart. & Gal.) Hemsl.
Fig. 22. *H. brevicornis* (HBK.) Don var. *Tuerckheimii* (Briq.) Allen.
Fig. 23. *H. brevicornis* (HBK.) Don var. *ovata* Allen.
Fig. 24. *H. brevicornis* (HBK.) Don var. *micranthella* (Briq.) Allen.
Fig. 25. *H. crassiuscula* Rob. & Seat.
Fig. 26. *H. caleoides* Allen.



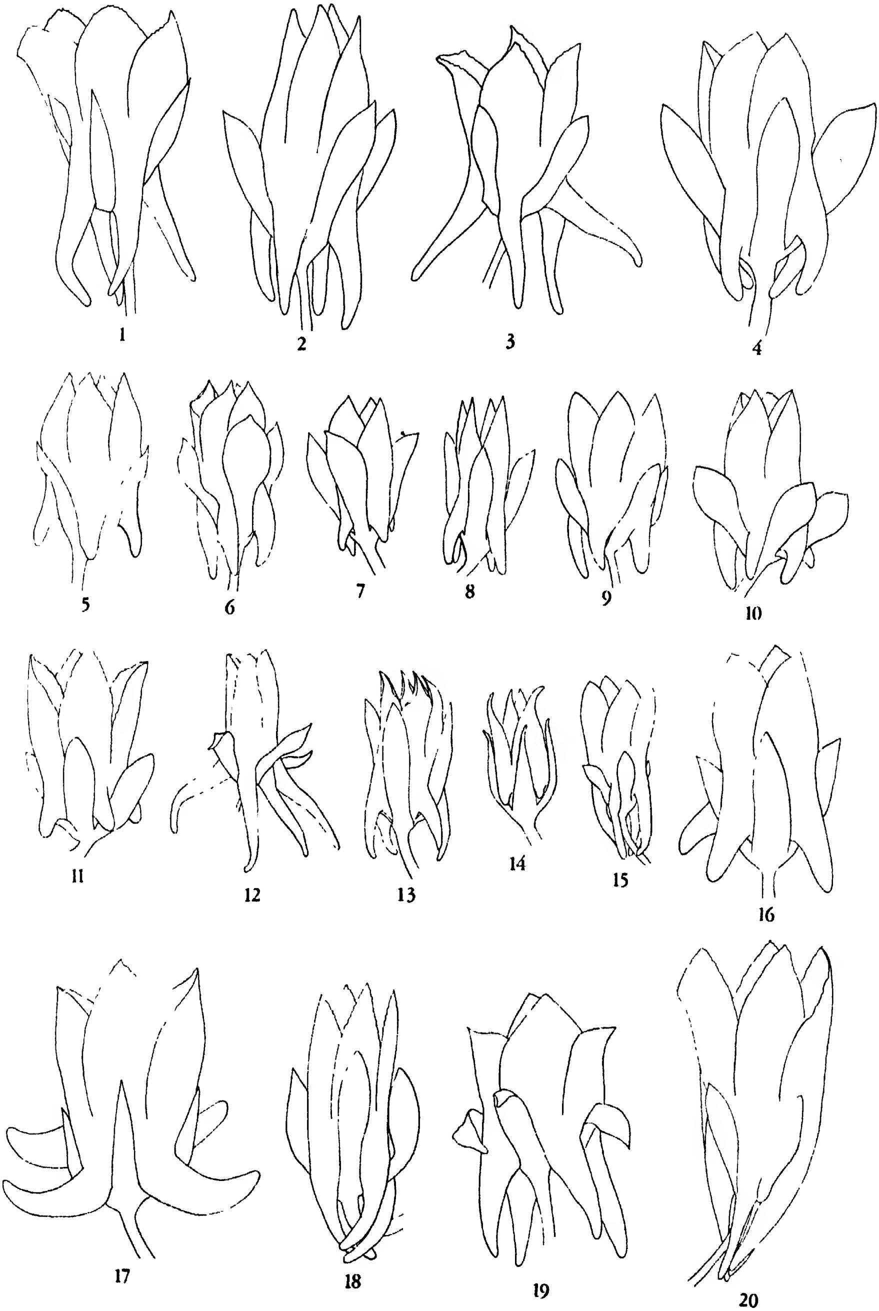
ALLEN—THE GENUS HALENIA

Explanation of Plate

PLATE 9

Camera-lucida drawings of the flower of the following species of *Halenia*. × 2.

Fig. 1. *H. Purdieana* Wedd. var. *congesta* Allen.
Fig. 2. *H. Meyeri Johannis* Gilg.
Fig. 3. *H. Weddelliana* Gilg.
Fig. 4. *H. Killipii* Allen.
Fig. 5. *H. Stuebelii* Gilg.
Fig. 6. *H. gracilis* (HBK.) Don.
Fig. 7. *H. robusta* Gilg.
Fig. 8. *H. minima* Allen.
Fig. 9. *H. penduliflora* Gilg.
Fig. 10. *H. spatulata* Allen.
Fig. 11. *H. caespitosa* Gilg.
Fig. 12. *H. bifida* Rusby & Allen.
Fig. 13. *H. vincetoxicoides* Gilg.
Fig. 14. *H. pusilla* Gilg.
Fig. 15. *H. silenoides* Gilg.
Fig. 16. *H. Hoppii* Reimers.
Fig. 17. *H. asclepiadea* (HBK.) Don.
Fig. 18. *H. Weberbaueri* Allen.
Fig. 19. *H. Rusbyi* Gilg.
Fig. 20. *H. umbellata* (R. & P.) Gilg.



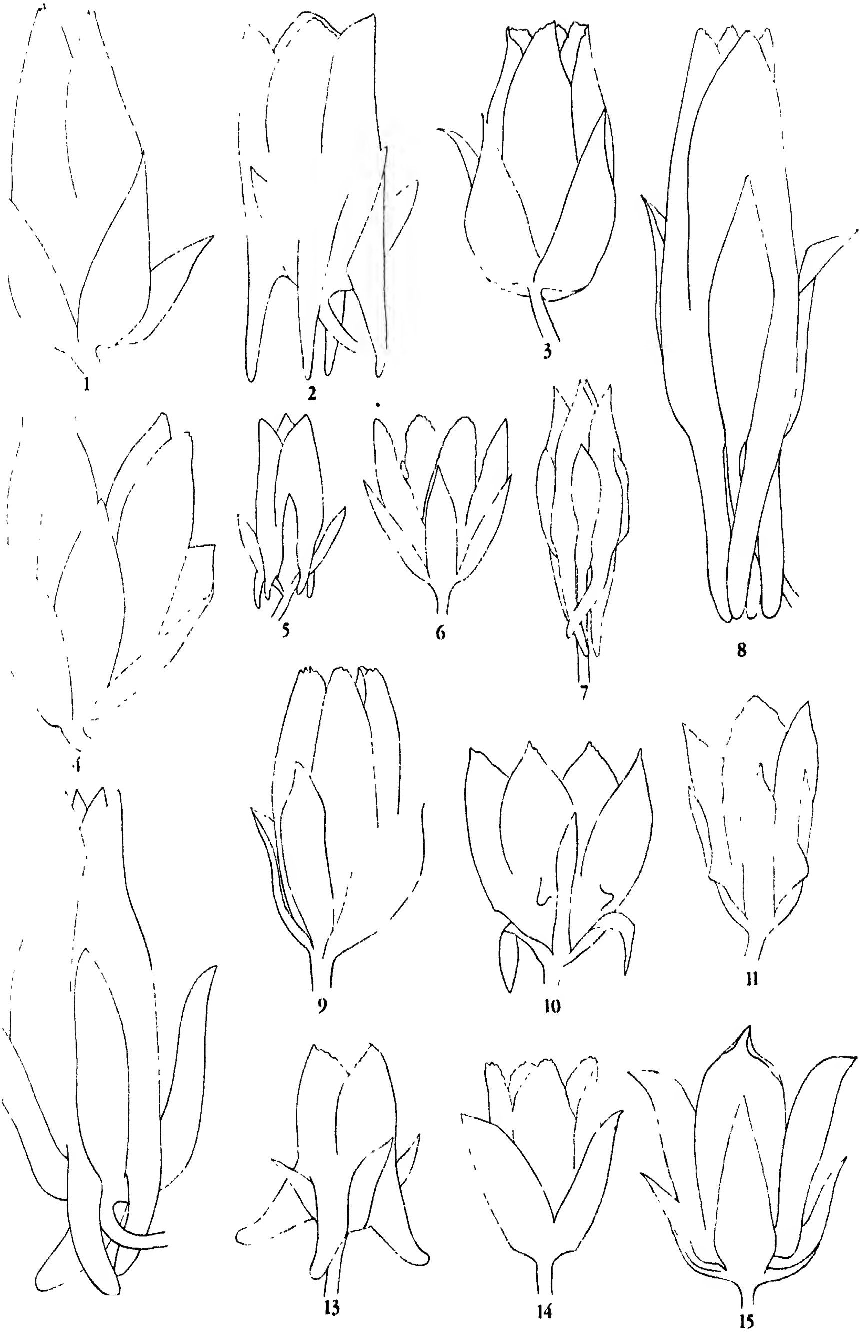
ALLEN—THE GENUS HALENIA

Explanation of Plate

PLATE 10

Camera-lucida drawings of the flower of the following species of *Halenia*. × 2.

Fig. 1. *H. verticillata* Gilg.
Fig. 2. *H. Purdieana* Wedd.
Fig. 3. *H. hygrophila* Gilg.
Fig. 4. *H. dasyantha* Gilg.
Fig. 5. *H. adpressa* Allen.
Fig. 6. *H. gentianoides* Wedd.
Fig. 7. *H. taruga gasso* Gilg.
Fig. 8. *H. elegans* Allen.
Fig. 9. *H. Tolimae* Gilg.
Fig. 10. *H. major* Wedd.
Fig. 11. *H. Karstenii* Gilg.
Fig. 12. *H. gigantea* Allen.
Fig. 13. *H. Kalbreyeri* Gilg.
Fig. 14. *H. inaequalis* Gilg.
Fig. 15. *H. parallela* Allen.



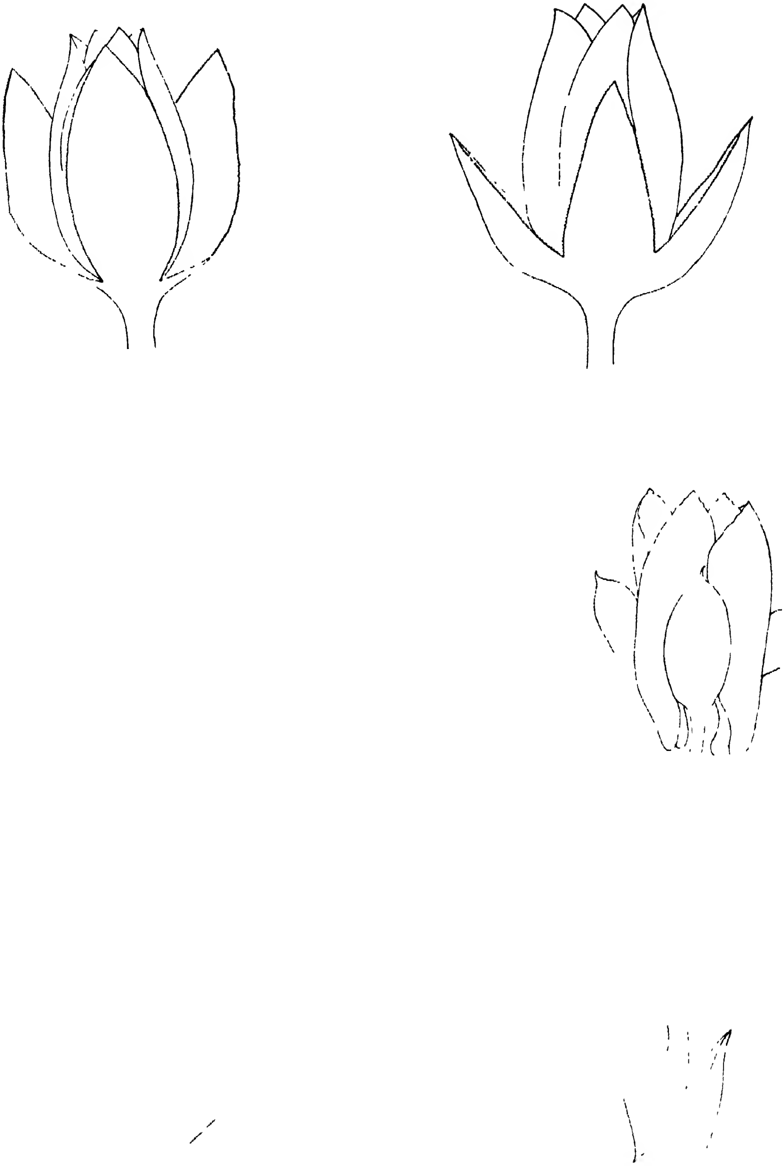
ALLEN—THE GENUS HALENIA

Explanation of Plate

PLATE 11

Camera-lucida drawings of the flower of the following species of *Halenia*. × 2.

Fig. 1. *H. subinvolucrata* Gilg.
Fig. 2. *H. viridis* (Griseb.) Gilg.
Fig. 3. *H. pulchella* Gilg.
Fig. 4. *H. bella* Gilg.
Fig. 5. *H. barbicaulis* Gilg.
Fig. 6. *H. elata* Wedd.
Fig. 7. *H. foliosa* Gilg.



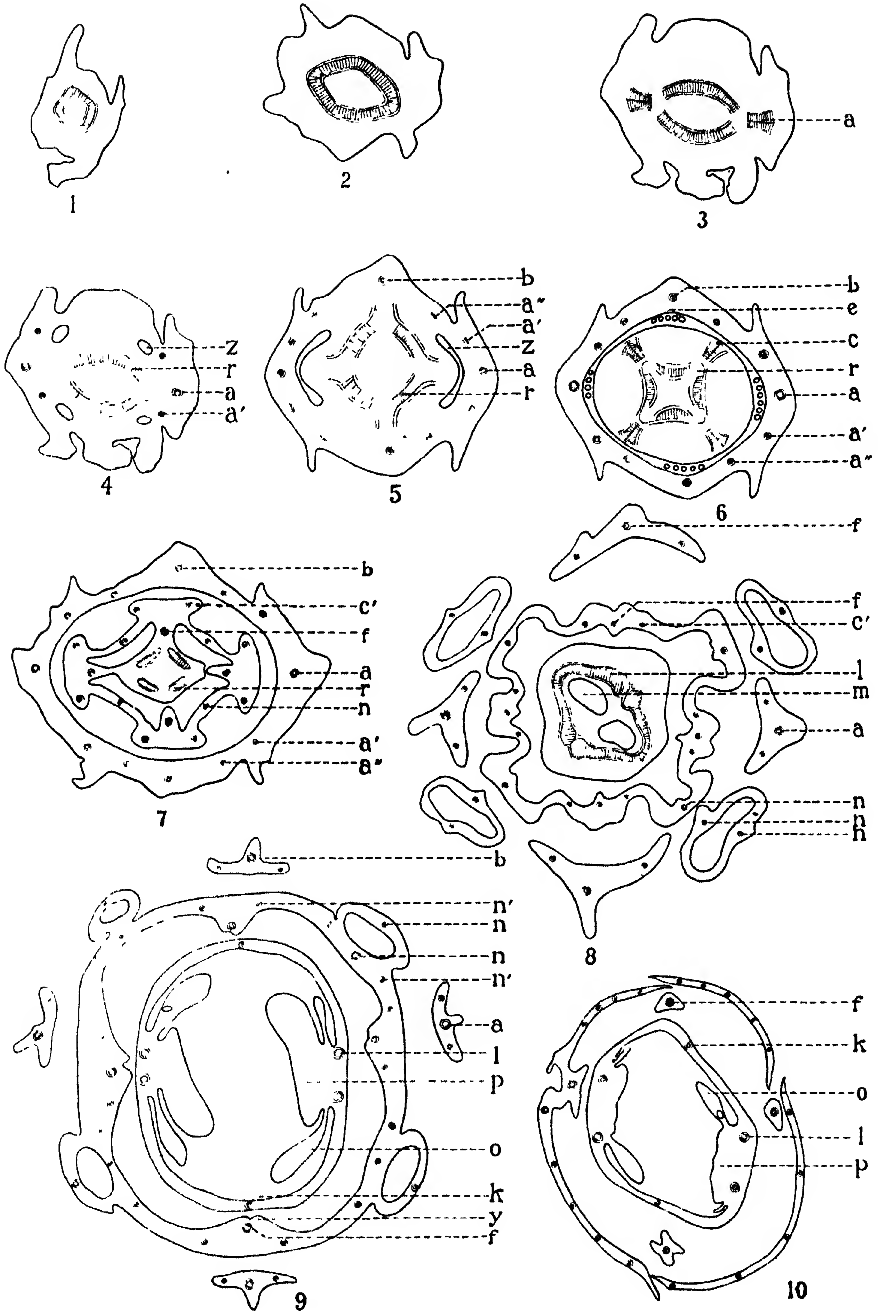
7

Explanation of Plate

PLATE 12

Diagrammatic serial transverse sections of the flower of *Halenia deflexa* (Sm.) Griseb. Explanation in the text.

del. A. Heinz



ALLEN—THE GENUS HALENIA

THE SENSITIVITY OF ORCHID SEEDLINGS TO NUTRITIONAL IONS

F. L. WYND

Assistant in the Henry Shaw School of Botany of Washington University

I. Introduction

The germination and growth of orchid seedlings on artificial media have received considerable attention from plant physiologists. Almost invariably, however, their investigations have been concerned with the carbohydrate metabolism to the exclusion of the inorganic nutritional relationships. The purpose of the present paper is to report the results of a study on the sensitivity of germinating orchid seeds and young seedlings to different nutritional ions. The few available data on inorganic nutrition are scattered in the papers dealing primarily with other phases of orchid development on artificial media.

Burgeff ('09) pointed out that orchid seeds germinated more favorably when nitrogen was available as ammonium sulphate than as a nitrate salt. This fact led Knudson ('22) to modify Pfeffer's solution, and this is the solution frequently mentioned in orchid literature as "Knudson's Solution B." Clement ('24, '24a) has said that the nutrition of different species of *Odontoglossum* varies widely, but he did not elucidate the matter further. Ballion and Ballion ('24) made a similar statement, that in their work with *Cattleya*, *Miltonia*, and *Odontoglossum* the nutritional conditions varied according to the species, but here again no specific information was given. La Garde ('29) found that his solution L gave about 10 per cent better growth than did Knudson's solution B, and attributed this superiority to the slight increase of nitrogen and the large increase of potassium and phosphorus in his solution. Smith ('32) used Knudson's solution B, but found that doubling or trebling the amount of ammonium sulphate gave better growth and a deeper color to his seedlings.

In so far as we have been able to ascertain, the above brief review is complete as to published data concerning the inorganic nutrition of orchid seedlings.

II. Methods

Livingston ('19) has clearly defined four possible criteria for the comparison of different nutrient solutions, as follows:—

(1) The volume-molecular proportion of any one salt.
(2) The osmotic proportion of any one salt.
(3) The total volume-molecular concentration.
(4) The total osmotic concentration.

As it is impossible to vary all the features of the composition of a series of solutions regularly at the same time, it is necessary to select arbitrarily one characteristic as the basis for comparison. Since it is probable that the solution must act upon plants primarily in an osmotic way, we have followed Livingston and many others in using the total osmotic concentration as the basis for comparative studies.

The triangular representation of a series of solutions of three components varying in any of the above ways was first introduced in physical chemistry by Schreinemakers ('93) and again by Bancroft ('02). Schreiner and Skinner ('10) first applied this method of investigating nutrition in their work on fertilizers. Since 1910 it has been used by various investigators to study the nutrition of several agriculturally important plants: wheat, by Shive ('15), McCall ('16), Livingston and Tottingham ('18), Van Alstine ('19), Meier and Halstead ('21), and by Tottingham and Rankin ('22); buckwheat, by Shive ('15, '17) and by Shive and Martin ('18, '18a); potato, by Johnston ('24) and by Martin and Shive ('20); celery, by Poole and Fant ('22); cranberry, by Addoms and Mounce ('31); peach seedlings, by Davidson ('28). After investigating the work of the above authors, it appeared to us that the triangular system of arranging a varying series of nutrient solutions provided the most satisfactory approach to the problem of the reaction of orchid seedlings to their inorganic substrate.

Seeds for the investigation were furnished from the greenhouses of the Missouri Botanical Garden through the courtesy of Dr. George T. Moore, the Director. Flowers of *Cattleya Trianae* Linden and Rchb. f. were pollinated November 17, 1930, and the largest and apparently the best pod was picked May 3, 1932, after a development period of almost eighteen months. It has

been the author's experience that in general the capsules first to mature furnish seeds of lower vitality than those maturing later; hence the one requiring the longest time to mature was used to supply seeds for the present work.

The nutrient solutions investigated were those of Type I and Type IV, as described by Livingston ('19). By the use of only three salts it is possible to arrange solutions containing the six major nutritional ions in six different combinations. Of these six possible combinations, only two will have all their ions added in unlike combinations. The compositions of the solutions used are given in tables I and II. In both types the total osmotic

TABLE I

TYPE I—KH_2PO_4, $Ca(NO_3)_2$, $MgSO_4$

Culture No.	Molecular proportion			Volume-molecular concentration		
	KH_2PO_4	$Ca(NO_3)_2$	$MgSO_4$	KH_2PO_4	$Ca(NO_3)_2$	$MgSO_4$
R1 S1	1	1	6	.0027	.0027	.0161
S2	1	2	5	.0025	.0049	.0123
S3	1	3	4	.0024	.0071	.0094
S4	1	4	3	.0022	.0089	.0067
S5	1	5	2	.0022	.0108	.0043
S6	1	6	1	.0020	.0122	.0020
R2 S1	2	1	5	.0053	.0027	.0132
S2	2	2	4	.0049	.0049	.0099
S3	2	3	3	.0047	.0071	.0071
S4	2	4	2	.0045	.0090	.0045
S5	2	5	1	.0041	.0104	.0021
R3 S1	3	1	4	.0076	.0025	.0101
S2	3	2	3	.0072	.0048	.0072
S3	3	3	2	.0068	.0068	.0045
S4	3	4	1	.0065	.0086	.0021
R4 S1	4	1	3	.0099	.0025	.0074
S2	4	2	2	.0094	.0047	.0047
S3	4	3	1	.0090	.0068	.0022
R5 S1	5	1	2	.0123	.0024	.0049
S2	5	2	1	.0118	.0047	.0023
R6 S1	6	1	1	.0145	.0024	.0024

TABLE II

TYPE IV—K_2SO_4, $Ca(H_2PO_4)_2$, $Mg(NO_3)_2$*

Culture no.	Molecular proportions			Volume-molecular proportions		
	K_2SO_4	$Ca(H_2PO_4)_2$*	$Mg(NO_3)_2$	K_2SO_4	$Ca(H_2PO_4)_2$	$Mg(NO_3)_2$
R1 S1	1	1	6	.0018	.0018	.0108
S2	1	2	5	.0018	.0036	.0092
S3	1	3	4	.0019	.0056	.0075
R2 S1	2	1	5	.0037	.0018	.0091
S2	2	2	4	.0037	.0037	.0074
S3	2	3	3	.0037	.0056	.0056
R3 S1	3	1	4	.0056	.0019	.0075
S2	3	2	3	0056	.0037	.0056
S3	3	3	2	0056	0056	.0038
R4 S1	4	1	3	.0076	.0019	.0057
S2	4	2	2	.0077	.0039	.0039
S3	4	3	1	.0078	0059	.0019
R5 S1	5	1	2	.0097	.0019	.0039
S2	5	2	1	.0098	.0039	.0019
R6 S1	6	1	1	.0116	.0019	.0019

* The solutions containing the highest proportion of $Ca(H_2PO_4)_2$ could not be prepared, because sterilization at the temperature and pH used caused precipitation.

concentration was one atmosphere. Mallinckrodt salts of highest reagent quality were used. One-hundred-cc. portions of the nutrient solutions were placed in 200-cc. Erlenmeyer flasks, 1.75 per cent of Merck's powdered "Reagent" agar added, and sterilized by autoclaving at 20 lbs. pressure for 20 minutes. Following the work of La Garde ('29), who found that maltose was the best source of carbohydrate, a 2 per cent concentration of this sugar was used in all cultures. A study of the hydrolysis of this sugar under our conditions of sterilization showed that about 10 per cent was hydrolyzed to glucose.

In addition to the six major nutrient ions there were added one-half part per million of manganese as manganese sulphate, and one-half part per million of boron as sodium borate. A ferric phosphate suspension was prepared as described by Living-

ston ('19) and 1 cc. added to each liter of nutrient solution. This gave ferric phosphate in the concentration of about 3 mgms. per liter.

Owing to the sensitivity of orchids to the acidity of the medium, each solution was so adjusted that the pH after sterilization was 4.8 to 5.0. Tables III and IV indicate the pH relationships before and after sterilization. The seeds were sterilized by shaking

TABLE III

THE ACIDITY RELATIONSHIPS OF TYPE I SOLUTIONS*

Sol. plus Fe, B, Mn, and 2% maltose	A	B	C
	pH as made up	pH adjusted before autoclaving	pH after 1.75% agar added and autoclaved
R1 S1	5.74	3.93	4.9
S2	5.10	3.91	5.0
S3	4.93	3.90	5.0
S4	4.90	3.90	5.0
S5	4.83	3.90	5.0
S6	5.08	3.90	5.1
R2 S1	4.86	3.93	4.8
S2	4.75	3.88	5.0
S3	4.73	3.93	4.9
S4	4.73	4.10	5.0
S5	4.83	4.10	5.0
R3 S1	5.26	4.22	5.0
S2	4.86	4.24	5.0
S3	4.83	4.20	5.0
S4	4.76	4.20	5.0
R4 S1	4.83	4.20	5.0
S2	4.81	4.22	5.0
S3	4.75	4.24	4.9
R5 S1	4.86	4.24	4.9
S2	4.83	4.22	4.9
R6 S1	4.80	4.29	4.9

* The pH determinations indicated in columns A and B were obtained by the quinhydrone electrode, while the results in Column C were obtained colorimetrically by the use of brom-cresol-green as an indicator.

TABLE IV

ACIDITY RELATIONSHIPS OF TYPE IV SOLUTIONS
DETERMINATIONS MADE AS INDICATED IN TABLE III

Sol. plus Fe, B, Mn, and 2% maltose	A	B	C
	pH as made up	pH adjusted before autoclaving	pH after 1.75% agar added and autoclaved
R1 S1	4.39	4.10	5.0
S2	3.71	4.18	4.9
S3	3.56	4.27	4.9
R2 S1	4.10	3.89	5.0
S2	3.67	4.20	4.9
S3	3.59	4.29	4.9
R3 S1	4.05	3.90	4.9
S2	3.73	4.22	5.0
S3	3.64	4.30	4.8
R4 S1	3.91	3.91	5.0
S2	3.69	4.25	4.9
S3	3.54	4.32	4.9
R5 S1	4.34	3.81	4.9
S2	3.78	4.15	5.0
R6 S1	4.27	3.90	5.0

20 minutes in a small vial of calcium hypochlorite solution prepared as described by Wilson ('15). They were then inoculated directly into the flasks of nutrient agar by a platinum wire inoculating needle. The flasks were incubated at 20–25° C. in a specially shaded greenhouse compartment. During the warmer summer days the greenhouse temperature could not be held below 30°, and on rare occasions 35°, but the short duration of these high temperatures apparently was without any harmful effect.

III. Results

Type I.—The growth period of these cultures extended from April 15 until November 12, 1932. At the end of this time, the

diameter of the seedlings was measured by a low-power microscope equipped with a calibrated eye-piece micrometer according to the method of Quednow ('30). The flasks had been very lightly inoculated so as to eliminate crowding of the growing seedlings. The figures in table v indicate the diameter in microns, each

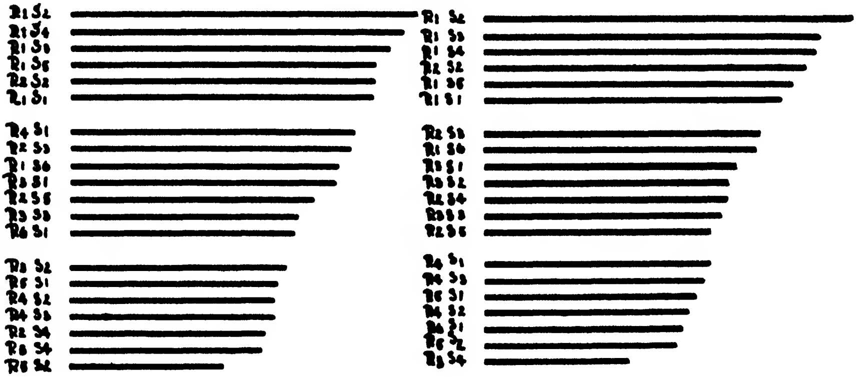
TABLE V

GROWTH OF SEEDLINGS IN TYPE I SOLUTION. THE FIGURES REPRESENT DIAMETERS IN MICRONS

Solution	Series 1	Series 2
R1 S1	915	910
S2	1100	1130
S3	970	1020
S4	1015	1010
S5	925	940
S6	810	830
R2 S1	(Contaminated)	(Contaminated)
S2	925	980
S3	855	845
S4	600	740
S5	740	690
R3 S1	805	775
S2	660	740
S3	690	725
S4	585	445
R4 S1	860	690
S2	620	620
S3	620	670
R5 S1	635	640
S2	475	585
R6 S1	680	615

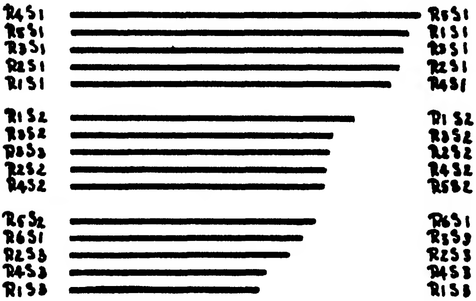
based on an average of 25 individuals. Figure 1 shows graphically the comparative development on the different media used. Figures 3 and 4 indicate the areas of the triangles corresponding to greatest, medium, and least growth. The circles are drawn to scale and represent comparatively the magnitude of the seedlings of the respective cultures.

Type IV.—The growth period of these cultures lasted from April 28 until November 20, 1932. Table VI presents the data for the growth on these solutions. As before, the diameter is indicated in microns and is the average of 25 determinations. Figure 2 shows graphically the comparative development.



a *b*

Fig. 1. *a:* diagrammatic representation of the relative diameters of seedlings germinated on Type I solution. Series 1; *b:* relative diameters of seedlings germinated on Type I solution. Series 2.



a *b*

Fig. 2. *a:* diagrammatic representation of the relative diameters of seedlings germinated on Type IV solution. Series 1; *b:* relative diameters of seedlings germinated on Type IV solution. Series 2.

Figures 5 and 6 show the areas of the triangles producing greatest, medium, and least growth, the circles being drawn as before to indicate the average diameters of the seedlings of the respective cultures.

TABLE VI

GROWTH OF SEEDLINGS IN TYPE IV SOLUTION. THE FIGURES REPRESENT DIAMETERS IN MICRONS

Solution	Series 1	Series 2
R1 S1	920	990
S2	825	825
S3	550	595
R2 S1	955	950
S2	740	740
S3	635	665
R3 S1	965	965
S2	765	770
S3	750	690
R4 S1	1010	950
S2	730	730
S3	570	630
R5 S1	975	1035
S2	715	715
R6 S1	675	705

IV. Discussion

Examination of figs. 3 and 4 shows perfect agreement between the duplicate series of Type I in the areas of greatest growth. These areas are characterized by having very low concentrations of KH_2PO_4. The five best cultures in row 1 have only one-eighth of the total osmotic concentration due to this salt. The ratios of calcium nitrate to magnesium sulphate are seen to vary between wide limits, .1667 to 2.500, with no significant effect on growth. The areas of medium and least growth do not show such perfect agreement in the duplicate series, but a comparison shows that the areas of medium growth correspond in general to those having the medium KH_2PO_4 concentration, and the areas of least growth correspond to those having the highest proportion of this salt. This relation is particularly clearly shown in fig. 4. From these data one may be led to the conclusion that germinating orchid seeds and young seedlings are comparatively sensitive to

varying concentrations of KH_2PO_4, but relatively insensitive to wide variations in $Ca(NO_3)_2$ and $MgSO_4$.

Since the ions were present as salts, it is impossible to determine which ion is responsible for the result. It is possible to add the six ions in but one other combination of three salts so that each anion will be linked with a different cation. This combination is represented by the Type-IV triangle. It is unfortunately impossible to prepare the complete Type-IV series because at the pH used (5.0) the solutions having the higher $Ca(H_2PO_4)_2$ concentrations precipitated on sterilization due to the decomposition of this compound.

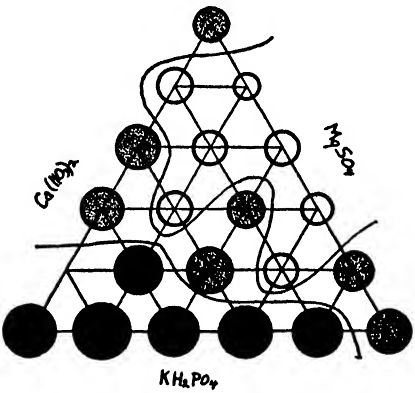


Fig. 3. Type I, series 1, showing areas of high, medium, and low yield. Culture R2 S1 omitted because of *Aspergillus* contamination.

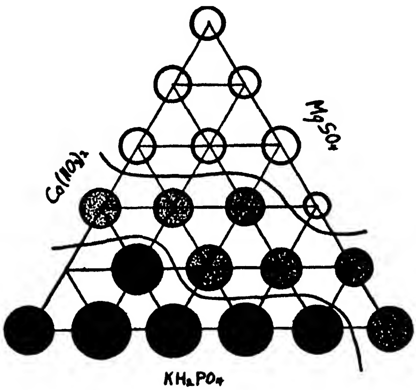


Fig. 4. Type I, series 2, showing areas of high, medium, and low yield. Culture R2 S1 omitted because of *Aspergillus* contamination.

Growth on the possible solutions of this type shows a remarkable result. The areas of greatest growth perfectly agree and are characterized by solutions having the minimal proportion of the total osmotic concentration due to $Ca(H_2PO_4)_2$. Again, the ratios of the other salts, K_2SO_4 to Mg $(NO_3)_2$ vary between wide limits, .1667 to 2.500, with very little effect on growth. The areas of medium growth correspond to those of medium concentration of this salt, and those of least growth correspond to the areas of high concentration of this salt.

This comparison of the growth on solutions of Type I with that on Type IV indicates that in both cases greatest growth was

associated with the lowest proportions of the phosphate salt, irrespective of which ion it accompanied, and that the relative proportions of all other ions were of comparatively little effect. The fact that growth was inversely proportional to the concentration of the $H_2PO_4^-$ ion seems to be related significantly to the results of Gregory ('28). This author studied the effect of the different ions on growth by an ingenious mathematical treatment of the results published previously by Johnston ('24) concerning the growth of potato plants in three-salt solutions. In studying duplicate series, Gregory found that in each the fraction of the total growth produced by the $H_2PO_4^-$ ion was a negative quantity.

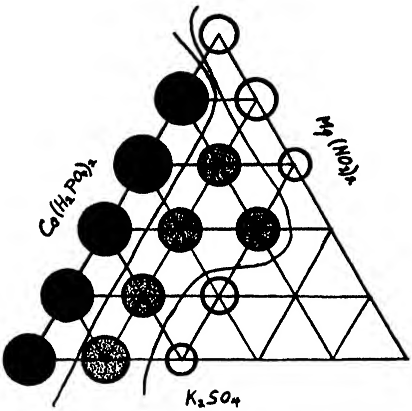


Fig. 5. Type IV, series 1, showing areas of high, medium, and low yield. The cultures of high concentration $Ca(H_2PO_4)_2$ omitted (see text).

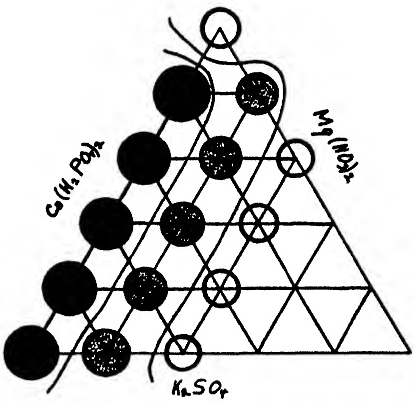


Fig. 6. Type IV, series 2, showing areas of high, medium, and low yield. The cultures of high concentration $Ca(H_2PO_4)_2$ omitted.

In general, he also found that the growth produced by other negative ions was much less than that produced by the positive ions.

If we indicate the concentration of each ion in a "molar" sense and compare the composition of the best solution of Type I and Type IV in table VII, an interesting analogy is apparent. Despite the great apparent variation in composition of these two solutions, we see that in both the concentrations of the negative ions are of the same order of magnitude, while those of the positive ions vary greatly. It seems therefore probable that growth was

being conditioned in both cases by the negative rather than the positive ions.

TABLE VII

CONCENTRATION OF IONS IN "MOLS" OF THE BEST SOLUTION OF TYPE I AND TYPE IV

	Type I	Type IV
$H_2PO_4^-$	.0025	.0038
NO_3^-	.0098	.0078
SO_4^{--}	.0123	.0097
K^+	.0025	.0194
Ca^{++}	.0049	.0019
Mg^{++}	.0123	.0039

These results need not be interpreted as contradictory to those of Smith ('32), who found that better growth was obtained in solutions having larger amounts of ammonium sulphate added to Knudson's solution B. Smith added nitrogen in the ammonium ion, while we used the nitrate ion. It is entirely possible that orchid seedlings might react favorably to an increase of nitrogen as the ammonium ion, while growth would not improve with increases in the form of nitrate. This is indeed made very probable by the work of Burgeff ('09), who found better growth with ammonium than with nitrate salts.

We are at a loss to relate these results to those of La Garde ('29) who states, in regard to superiority of his solution L over that of Knudson's solution B, as follows:—"The seedlings appeared darker in color and had progressed relatively further in development. This effect might be ascribed to the larger dose of phosphorus and potassium." Experiments now in progress, which will be reported later, show that La Garde's solution L is indeed a very favorable orchid medium, but it seems probable that we may not ascribe this quality to the increase of phosphorus and potassium *per se*.

This study further emphasizes the suggestion made by some authors that the Ca:Mg ratio is not of such importance as it was once thought. At least the limits of variation used in our experiments were not sufficiently great to produce any significant effect.

V. Summary

Seeds of *Cattleya Trianae* Linden and Rchb. f. were germinated on three-salt solutions of Type I and Type IV, with the following results:—

(1) The seedlings showed best development on media having low proportions of the total osmotic concentration due to the phosphate salt, irrespective of whether it was present as the potassium of the calcium compound.

(2) The proportion of all other ions within the limits used appeared to have relatively little effect on germination and growth.

(3) The negative ions appeared of greater importance in conditioning orchid seedling development than the positive ions.

(4) The best growth in Type I solutions was found in culture R1 S2 having the composition:—

KH_2PO_4	.0025 M
$Ca(NO_3)_2$	.0049 M
$MgSO_4$	.0123 M

(5) The best growth in Type IV solutions occurred in culture R5 S1 containing:—

K_2SO_4	.0097 M
$Ca(H_2PO_4)_2$	.0019 M
$Mg(NO_3)_2$	.0039 M

VI. Acknowledgements

The author wishes to thank Dr. George T. Moore, Director of the Missouri Botanical Garden, for furnishing seeds for this investigation; and also to express his appreciation to Elinor Alberts Linder, formerly Orchidologist to the Missouri Botanical Garden, for helpful suggestions while employed at this institution; and also to Dr. E. S. Reynolds, under whose supervision the work was carried out.

Bibliography

Schreinemakers, F. A. H. ('93). Konzentrierung oder Verdünnung einer Lösung bei konstanter Temperatur. Zeit. Phys. Chem. **11**: 81–85. 1893.

Bancroft, A. D. ('02). Synthetic analysis of solid phases. Jour. Phys. Chem. **6**: 178– . 1902.

Burgeff, H. ('09). Die Wurzelpilze der Orchideen; ihre Kultur und ihr Leben in der Pflanze. Jena, 1909.

Schreiner, O., and Skinner, J. J. ('10). Ratio of phosphate, nitrate, and potassium in absorption and growth. Bot. Gaz. **50**: 1–30. 1910.

Shive, J. W. ('15). A three salt nutrient solution for plants. Am. Jour. Bot. **2**: 157–160. 1915.

Wilson, J. K. ('15). Calcium hypochlorite as a seed sterilizer. *Ibid.* 420–427. 1915.

McCall, A. G. ('16). Physiological balance of nutrient solution for plants in sand cultures. Soil Sci. **2**: 207–253. 1916.

Shive, J. W. ('17). A study of physiological balance for buckwheat in three-salt solution. N. J. Agr. Exp. Sta. Bull. 319: 1–63. 1917.

————, and Martin, W. H. ('18). A comparative study of salt requirements for young and for mature buckwheat plants in solution cultures. Jour. Agr. Res. **14**: 151–175. 1918.

————, ('18a). A comparison of salt requirements for young and for mature buckwheat plants in water culture and sand culture. Am. Jour. Bot. **5**: 186–191. 1918.

Livingston, B. E., and Tottingham, W. E. ('18). A new three-salt nutrient solution for plant cultures. *Ibid.* 337–346. 1918.

————, ('19). A plan for comparative research on the salt requirements of representative agricultural plants. Baltimore, 1919.

Van Alstine, E. ('19). The relation of salt proportion to the growth of wheat in sand cultures. N. J. Agr. Exp. Sta. **40**: 366–374. 1919.

Martin, W. H., and Shive, J. W. ('20). A study of the salt requirements of the potato. N. J. Agr. Exp. Sta. Rept. **41**: 409–412. 1920.

Meier, H. F. A., and Halstead, C. E. ('21). Hydrogen-ion concentration relations in a three-salt solution. Soil Sci. **11**: 325–352. 1921.

Tottingham, W. E., and Rankin, E. J. ('22). Nutrient solutions for wheat. Am. Jour. Bot. **9**: 270–276. 1922.

Knudson, L. ('22). Non-symbiotic germination of orchid seeds. Bot. Gaz. **73**: 1–25. 1922.

Poole, R. F., and Fant, G. W. ('22). Further study of the relation of various fertilizers mixtures to the growth of celery in muck soil. N. J. Agr. Exp. Sta. Rept. **43**: 395–399. 1922.

Clement, E. ('24). Germination of Odontoglossum and other seed without fungal aid. Orchid Rev. **32**: 233–239. 1924.

————, ('24a). The non-symbiotic germination of orchid seeds. *Ibid.* 359–366. 1924.

Ballion, M., and Ballion, G. ('24). The non-symbiotic germination of orchid seeds in Belgium. *Ibid.* 305–309. 1924.

Johnston, E. S. ('24). Growth of potato plants in sand cultures treated with the "six types" of nutrient solutions. Md. Agr. Exp. Sta. Bull. 270: 53–86. 1924.

Davidson, O. W. ('28). An application of the triangle system in determining a nutrient solution suitable for research with the peach in sand culture. Am. Soc. Hort. Sci., Proc. **25**: 354–358. 1928.

Gregory, F. G. ('28). The differential effect of the ions of three-salt solutions on the growth of potato plants in sand cultures. Roy. Soc. Lond., Proc. B. **102**: 311–327. 1928.

La Garde, R. ('29). Non-symbiotic germination of orchids. Ann. Mo. Bot. Gard. **16**: 499–514. 1929.

Quednow, K. G. ('30). Beiträge zur Frage der Aufnahme gelöster Kohlenstoffverbindungen durch Orchideen und andere Pflanzen. Bot. Archiv. **30**: 51–108. 1930.

Addoms, Ruth M., and Mounce, F. C. ('31). Notes on the nutrient requirement and the histology of the cranberry (Vaccinium macrocarpon Ait.) with special reference to mycorrhiza. Plant Physiol. **6**: 653–669. 1931.

Smith, F. E. V. ('32). Raising orchid seedlings asymbiotically under tropical conditions. Gard. Chron. **91**: 9–11. 1932.

Verbénacées," pointed out that the genus was a composite one containing several units. Amongst these he showed that *Verbena* differed from the others in having four stamens and four nutlets. This definition was accepted by Endlicher[5] under the heading "VERBENAE VERAE," and it has continued to the present time.

Although the genus is predominantly American, the earliest species were described largely from plants grown in various European gardens. This was unfortunate, since such types are often extinct or inaccessible or sometimes difficult to interpret on account of probable fusion or other modifications appearing in the species after some few years of cultivation. The first treatment of the North American species, as such, is that of Michaux.[6] He recognized eight species, all from the region of the middle and southeastern United States. From time to time new species were collected by pioneer explorers. Kunth[7] described eight from the Mexican region, Bentham[8] added three more, and Martens and Galeotti[9] reported eleven, of which six were new. The ablest and most inclusive work on the genus as a whole is that of Schauer.[10] In this he accepted seventy-one species and listed fourteen more as insufficiently known; of these, twenty-seven are indigenous to North America. Appearing about the same time as Schauer's work is that of Walpers,[11] whose review might be considered as an assembling of the literature of the genus rather than the results of a special monographic study; nevertheless, it is comprehensive and contains a few new species. Subsequently no publication of the North American species *in toto* has appeared, although the works of Gray[12] and Small[13] are very helpful in so far as regional floras are concerned. The last two publications contain the only keys to the group under consideration.

The type-species of the genus is *V. officinalis* L.

[5] Endlicher, Gen. Pl. 633 (no. 3685). 1838.
[6] Michaux, Fl. Bor.-Am. 2: 13–15. 1803.
[7] HBK. Nov. Gen. et Sp. 2: 272–277. 1818.
[8] Bentham, Pl. Hartw. 21. 1839.
[9] Martens & Galeotti, Bull. Acad. Brux. 11[2]: 320–324. 1844.
[10] Schauer in DC. Prodr. 11: 535–556. 1847.
[11] Walpers, Rep. 4: 13–33. 1844–48; 6: 686–687. 1846–47.
[12] Gray, Syn. Fl. N. Am. 2[1]: 335–338. 1878.
[13] Small. Fl. Southeast. U. S. ed. 1. 1008–1011. 1903.

Gross Morphology

Roots.—Some species are annual with a fibrous root system branching from a slender primary root; others are perennial with a larger tap-root. They maintain themselves from year to year by crowns from which clustered new shoots rise near the base of the old ones. A few species show a tendency to root at the nodes. Probably, for the most part, the main purpose of these secondary roots is to aid in obtaining nourishment for the plant, as instance, *V. canadensis,* a hardy plant with stems rooting only at the lower nodes. Nevertheless, in *V. teucriifolia,* they may be a possible means of propagation, as definite roots are found at more or less remote nodes; occasionally, both roots and fruiting spike are developed from the same node. In many cases, it is difficult to tell whether a species is an annual or only a short-lived perennial. The question of duration depends in some measure on climatic factors.

Stems.—The stems are slender, terete, or, more commonly, quadrangular in cross-section with sharp or obtuse angles, and chiefly pubescent. Apparently all are herbaceous, the perennials dying down to the ground in winter and reappearing again in the spring. The shorter forms branch freely with decumbent-ascending or prostrate branches; the taller are usually erect with branches loosely ascending-spreading. All the lower branches are opposite, but the upper may be somewhat irregularly placed.

Leaves.—In the majority of the species of the section *Glandularia* the leaves are deeply cleft, whereas those of the *Verbenaca* are in large part merely dentate or incised. As a whole they are membranaceous, varying greatly in size and somewhat in thickness. In a few species they are strictly sessile; in most, however, they are either subsessile or short-petioled and tend to be strongly veined beneath. All have more or less short, sheathing, and connate bases. In general the leaves are opposite, but at times they are subalternate or irregularly disposed on the upper part of the stem; they are rarely ternate, and this arrangement appears to be an individual expression rather than a specific or even a varietal character.

Pubescence.—The trichomes are simple and unicellular, varying in quantity, length, rigidity, coarseness, and direction. None

of the pubescence is truly hispid, but in some species the hairs are slightly stiffer than in others; this indument, as exemplified in the calyx of *V. bipinnatifida*, is designated as "hispid-hirsute." In *V. prostrata* and *V. Gooddingii* the pubescence is characteristically soft-villous, but in the majority of species the general tendency is to approach a hispidulous-hirsute to strigillose condition. In the former instance, the trichomes, especially along the stem and on the inflorescence, are of different lengths and more or less spreading; whereas in the latter, as in *V. tampensis*, they are short, approximately equal, and appressed. Often the hairs of the upper surface of the leaf spring from minute bulbous bases; these, according to Solereder,[14] are calcified or silicified hairs, and the trichomes with somewhat pustulate bases, in *V. carolina* and occasionally in other species, are cystolith-hairs. In any case, Solereder did not find cystoliths dissociated from the hairs. A viscid condition is rarely present, but glandular hairs are widely distributed throughout the genus.

Inflorescence.—The inflorescence is terminal at the apices of stems or branches. The flowers are subtended by bracts and are borne in solitary or somewhat panicled or cymosely arranged spikes. Although these vary considerably, it is fairly easy to determine the section to which a plant belongs by the type of its spike.

In the majority of the indigenous North American species of the *Verbenaca*, the spikes are elongated and tend to be irregularly placed, as in *Verbena carolina*, so that they appear more or less panicled. In *V. sphaerocarpa* and *V. litoralis*, however, they are commonly arranged in simple or compound cymes. A spike may be either very slender with the flowers somewhat remote, or dense with imbricated flowers. In general, the elongated and comparatively narrow spike with small and inconspicuous flowers is a distinctive feature of the *Verbenaca* native to our continent.

On the other hand, the spikes characteristic of the section *Glandularia* are shorter and relatively broad with larger and more showy flowers. In the earlier stages of anthesis these are in fascicle-like clusters; later, when the rhachis elongates, the inflorescence becomes spicate.

[14] Solereder, Syst. Anat. Dicot. ed. 2, 1: 631–633. 1908.

Calyx.—The calyx is tubular, 5-lobed or subtruncate, 5-nerved and persistent. The nerves protrude somewhat beyond the margin of the lobes, forming calyx-teeth; these vary more or less specifically and occasionally intraspecifically. The nerves are unequal in length and the posterior one, along which the calyx ruptures to release the schizocarp, is always the shortest. In the *Glandularia*, the calyx is at least twice as long as the schizocarp and at maturity the teeth and lobes are more or less contorted. In contrast, the calyx of the *Verbenaca* is generally shorter and may be either connivent, concealing the schizocarp as in *V. scabra*, or, as in such species as *V. urticifolia* and *V. officinalis*, open, disclosing the apices of the nutlets. With the developing ovary, the calyx enlarges a little at the base; usually it is somewhat angled, but in *V. tumidula* it is round at the base and tends to be inflated. Although only relative in value, the pubescence of the calyx is probably of more worth in specific determination than the other previously mentioned characters.

Corolla.—The corolla is salverform and various in color. The tube is either straight or incurved, as long as or much longer than the calyx, and uniform or slightly enlarged at the throat. The degree of the exsertion of the corolla-tube is apparently a convenient and obvious character, but one to be handled with care; first, it is somewhat variable, and second, when the corolla falls after anthesis, it does not drop at once but may be some little time working its way out of the calyx-tube; hence, the length of the exserted portion appears much greater than it really is. The limb is lobed and may be either conspicuous (6–12 mm. broad) or inconspicuous (2 mm. broad). The shape and the direction of the lobes may be of value in field identification but are not at all satisfactory in work on herbarium material. The throat inside is bearded with straight minutely roughened retrorse hairs and at the orifice with moniliform ones; outside and beyond the calyx it is either glabrous or finely pubescent. The inner hairiness is more prominent in the section *Glandularia*.

Stamens.—The stamens are didynamous, often very short-stalked, and in the North American species, inserted on the upper middle half of the corolla-tube, but not exserted. In *V. bipinnatifida* and all the related species of its section, the anterior pair

is very near the orifice of the throat and usually bears a gland-like appendage on the connective. The stamens are too much alike to be useful in specific differentiation.

Pistil.—The ovary is superior, bicarpellary, and entire or very shallowly lobed at the apex. The style varies in length with the length of the corolla-tube, bearing the mature stigma approximately in the region of the lower anthers. The typical form is slender and bilobed, the posterior lobe being sterile and laterally compressed, the anterior stigmatic and broad. The relation of these lobes to each other is reasonably constant throughout each section of the genus. In *V. scabra*, however, the broad stigmatic surface appears to be subtended on either side by a sterile style-lobe. Another interesting variation of the style is produced by *V. quadrangulata;* here, the base is enlarged or thickened into a somewhat hemispherical-angulate stylopodium and persists as an integral portion of the nutlets.

Fruit.—The fruit of *Verbena* is a schizocarp enveloped by the persistent calyx. As previously stated, the calyx splits along the posterior nerve to release the schizocarp attached to a more or less round-quadrangular gynobase. For the most part, four nutlets or pyrenae develop, two from each biovulate carpel. Generally the nutlets are either subcylindric or subtrigonous, but in *V. quadrangulata* they are beaked cylindric, and in *V. tumidula* subovoid. The dorsal surface is more or less convex with the lateral surfaces scarcely definite, rather appearing as continuations of the dorsal portion and adjoining the commissural face or faces. This is not always the case, since in *V. tumidula* the lower part of the nutlet seems inflated and the lateral is somewhat ventricose and smooth. The surface of the nutlet varies from essentially smooth, as in *V. carolina* and its allies, to striate or sulcate, and is oftenest raised-reticulate or reticulate-scrobiculate on the upper part. Occasionally, the character or scope of these depressions is of specific value, as in *V. gracilis;* but usually a certain type of nutlet is characteristic of a group of species rather than a single one.

The commissure may be more or less muricate or practically smooth. In the subcylindric pyrenae of the section *Glandularia*, the commissural face is commonly convex and does not extend

to the tip of the nutlet; whereas in the trigonous nutlets of the *Verbenaca,* the commissure ordinarily has two faces meeting at right angles, and is as long as the nutlet.

The gynobase varies with the size and shape of the pyrenae which it bears. In *V. carolina* and *V. Ehrenbergiana,* it is nearly flat and almost orbicular, but in species with larger nutlets, as in *V. simplex* and *V. neomexicana,* it is slightly deeper and in large part somewhat quadrangular. It shows its greatest development in the section *Glandularia* where the pyrenae are largest and often somewhat broadened at the base. Perhaps the gynobase should be used as a character complementary to that of the nutlets, but its definite value is rather elusive.

The more important morphological characters, which have been used in the delineation of the genus and its sections, are illustrated with a legend (pl. 13).

Hybrids.—It is a well-accepted fact that the cultivated races of *Verbena* have arisen through the more or less fusing of species attractive for horticultural purposes. Granting this, without field observation and knowledge gained through experimental work, the writer does not propose to discuss the question of hybridization in *Verbena.* Nevertheless, it is necessary to point out that there is a considerable number of specimens amongst the collections of this genus from the Middle States, which show variation in several directions or a combination of the characters of two or more species; it is the prevailing opinion that these plants are hybrids.

Relationships and Distribution

The genus *Verbena* is a member of the tribe *Verbeneae* according to Engler and Gilg,[15] or of the *Euverbeneae* according to Briquet in Engler and Prantl.[16] It is distinguished from its immediate relatives by the four dry and hardened nutlets. In this paper fifty-one species are recognized, four naturalized and forty-seven indigenous. With the exception of a few border-line species, it is relatively easy to separate the genus into two fairly distinct sections in which the majority of the members are so

[15] Engler & Gilg, Syllab. der Pflanzenf. eds. 9 & 10, 339. 1924.
[16] Engler & Prantl, Nat. Pflanzenf. 4^{3a}: 146. 1895.

different that it would seem as if they had followed divergent trends for a long period of time. In attempting to present any genus in a natural order, it is highly desirable to know what species are primitive. However, without an intimate knowledge of the more diversified South American species, it seems preferable to state the evidence derived from the study of the North American group and leave the conclusions vague rather than more or less arbitrary.

The section *Verbenaca* is probably the older of the two. It has the wider distribution, ranging from Canada to Panama as well as from the east to the west coast of United States and Mexico. Also, it is larger, containing thirty-two species. A number of these are annual, the remainder are perennial, but it is often hard to distinguish the members by this criterion. Although admittedly varying and apparently intergrading, the species as a whole are more stable and more readily recognized than those of the section *Glandularia*. The flowers are much smaller and for the most part are produced in greater abundance; the nutlets also are abundant and in some cases minute. The combination of these characters leads one to conclude that this section is the more primitive one.

Within the section, some species appear to be more closely related than others. *V. officinalis*, *V. menthaefolia*, *V. Halei*, and *V. riparia* form a natural group possessing the same general habit, type of pubescence and of nutlets. These are species of more or less adjacent regions except *V. officinalis*, which has been introduced from Europe. Again, *V. Ehrenbergiana*, *V. carolina*, *V. longifolia*, and *V. recta* are very closely related, with *V. urticifolia* and *V. scabra* only a little farther removed. The last five species differ from the first mentioned in their more or less upright habit and less divided leaves, also in their smaller and somewhat smoother nutlets. It would appear as if all had arisen very close to the ancestral form and diverged only a little in the process of adaptation to environment.

V. hastata and *V. simplex* are quite distinctive in habit, but the abundance of intermediate forms occurring between these and the two species, *V. stricta* and *V. bracteata*, would seem to indicate a close relationship amongst these units. *V. Orcuttiana*, although

somewhat isolated, appears to have its nearest affinity in *V. simplex.*

A third closely related group contains *V. canescens*, *V. neomexicana*, *V. plicata*, and *V. gracilis;* the common characters here are those of leaf-incision, pubescence, and general features of inflorescence. *V. perennis* resembles this group in all respects except in its quite aberrant pubescence of short antrorse and hispidulous trichomes; in this character it simulates more closely the first-mentioned group.

The following are more or less isolated species of limited distribution and with fairly static characters: *V. xutha*, *V. prostrata*, and *V. robusta*. *V. carnea* is probably a relic of some ancient form; the distinctive character of the schizocarp gives no clue to its affinities, but rather emphasizes the anomaly of the species.

The section *Glandularia* seems to be the more nascent. The species are perennial, developing from a crown, and have a more or less sprawling to upright habit. The characters are highly variable and some species are difficult to distinguish, apparently passing into each other. Particularly is this true of *V. ambrosifolia*, *V. Wrightii*, and *V. ciliata*. Some of the specimens from northern Mexico have been most perplexing; while it is perfectly evident that they belong to this group, none of them is typical. *V. bipinnatifida* is a closely related and wide-ranging species; by comparison, its characters are fairly clear-cut. The remaining species of the section are easily associated in groups or are anomalous. *V. canadensis*, *V. maritima*, and *V. tampensis* are very much alike either in habit or in floral structure. *V. tampensis*, however, is one of the species of this group where the glands may or may not be present on the anthers, and may represent the development of some transitional stage between the two sections. *V. elegans* of Mexico is very closely parallel to *V. canadensis* of the southeastern and central United States. *V. delticola* seems to belong in this association also; yet it is interesting to note that its fruit shows a tendency to develop a beak, and this may be significant of some little affinity with *V. quadrangulata*, a species so aberrant that it has been treated as a separate genus. *V. Gooddingii*, *V. tumidula*, and *V. pumila*

might very well be related to any of the previously mentioned species of the section. *V. setacea* resembles *V. Gooddingii* var. *nepetifolia* in habit, but it has such long calyx-teeth that one is a little hesitant about expressing any ideas of its relationship. *V. teucriifolia* and *V. ciliata* appear to intergrade in Mexico. The former, as well as *V. pumila,* shows a tendency toward reduced corollas and perhaps parallel development. *V. lilacina* and *V. amoena* are without close relatives.

Considering the genus as a whole, some species are in a state of flux showing many atypical forms and covering fairly large geographic areas; others are just as widespread and yet are characterized by more static characters; and again, others are endemic showing a very limited distribution and appearing as outlying members of the group. The species probably vary from youth to age in the order mentioned.

As previously stated, the genus *Verbena* is fairly widely distributed in North America; its range extends from southern Canada to Panama and from the east coast to the west both in United States and in Mexico. It is found also in the West Indies and on islands in the Pacific off the coasts of California and Mexico. It occurs in great abundance in Texas, New Mexico, and Arizona, south along the Sierra Madre and throughout the eastern part of Mexico. It is also fairly well distributed in southern Mexico, but only a few species are reported from Central America. The region of greatest specific concentration for North America is in the state of Texas, where twenty out of the forty-seven indigenous North American species are represented. Amongst these species are members of both sections, some with very definitely clear-cut characters and more or less limited distribution, others with fluctuating characters and more widely distributed.

By way of contrast, let us consider the outlying members of the genus which have stable characters and are isolated or inhabit very limited areas—*V. lilacina, V. sphaerocarpa, V. Orcuttiana, V. setacea, V. macrodonta, V. amoena,* and *V. subuligera;* or again species such as *V. carnea* and *V. quadrangulata,* which are singular but have a larger geographic range. All these appear to be relics of a more ancient distribution. Undoubtedly

V. lilacina and *V. sphaerocarpa,* endemics of Cedros and Socorro Islands respectively, developed as a result of geographic isolation. The same may be true of the Lower Californian entities, *V. macrodonta, V. setacea,* and *V. Orcuttiana.* Perhaps *V. amoena* from Lecheria, a locality some little distance north of the city of Mexico, and *V. subuligera,* from the Sierra Madre west of Durango, owe both their restriction and their differentiation to the presence of mountainous barriers. However, the same conclusion is hardly valid for either *V. carnea,* ranging from North Carolina to Florida and west to Texas, or *V. quadrangulata,* of southern Texas and Tamaulipas; yet they are probably relic endemics which have survived in favoring areas. If this be true, here is another bit of interesting evidence supporting the idea that the *Verbenaca* is the older of the two sections. Of the nine species enumerated above as being of more ancient derivation, four, *V. setacea, V. lilacina, V. amoena,* and *V. quadrangulata,* have been placed in the section *Glandularia;* yet, in the flowers examined, the anthers are definitely unappendaged. To be sure, this disposition of the species is not in accord with the previous classifications and may not be acceptable; nevertheless, it seems logical to believe there must be transitional forms in the development and evolution of species; and in this case, the major portion of the characters of the species in question are those of the section *Glandularia.* Two other species which have developed a little farther along this same line are *V. tampensis* and *V. pumila;* gland-like appendages may or may not be present on the anthers; if present, they are usually very small.

It may be of interest to note that, in agreement with Jordan's law of distribution, the species associated in groups usually occupy adjacent regions.

Now as to origin.—It is possible that the progenitors of *Verbena* were very widespread at the beginning of the Pleistocene and with the glacial advance migrated southward; later, when more favorable climatic conditions developed they spread northward, establishing themselves in the present regions of distribution. Another possibility is that the centre of distribution is in South America and migration has been northward. However this may be, *V. litoralis* is the only known species indigenous to both

countries and does not seem to be very closely related to the remaining North American species. Without a detailed investigation of the South American group, it seems preferable to reserve assumptions in the matter.

Economic Value

Verbena is of very little value economically. It was introduced into cultivation in European gardens relatively early in the history of botanical explorations. Although not so popular as it was once, on account of its vigor and hardiness, it is still used in many gardens to impart bright colors to the landscape.

Taxonomy

Verbena [Tourn.] Linn. Gen. Pl. 12. 1754.

Obletia Rozier, Jour. Phys. 1: 367, *pl. 2*. 1773.

Glandularia Gmel. Syst. Veg. 920. 1791.

Billardiera Moench, Meth. 369. 1794.

Shuttleworthia Meisn. Pl. Vasc. Gen. 290. 1839, and Comm. 198. 1839.

Uwarowia Bunge, Acad. St. Petersb. Bull. Sci. 7: 278. 1840.

Calyx tubular, 5-toothed, 5-nerved, at maturity often slightly enlarged at the base, persistent. Corolla minute to conspicuous, hypocraterimorphous, subbilabiate, 5-lobed; tube erect or incurved, uniform or slightly enlarged above, equalling the calyx-lobes or surpassing them; lobes imbricate in the bud, broadly oblong, obtuse or retuse, unequal. Stamens 4, didynamous, included; anthers ovate, unappendaged or the connective of the upper pair expanding extrorsely into a clavate and gland-like appendage; filaments usually short, attached above the base of the corolla-tube. Ovary superior, entire at apex or very shortly 4-lobed, bicarpellary, 4-loculed; ovules in pairs, one to each locule, anatropous; style terminal, mostly bilobed, the anterior lobe stigmatose and the posterior usually sterile. Schizocarp included in the persistent calyx, dry, hardened or brittle, separating into 4 homomorphous nutlets. Seed erect; embryo straight; endosperm none.—Chiefly American. Herbs or shrubs, erect or decumbent to prostrate, pubescent or occasionally glabrous. Leaves opposite, rarely ternate or verticillate, or the upper

alternate (irregular), variously dentate, incised or dissected, not often entire. Spikes terminal, rarely axillary, peduncled or sessile, densely flowered or elongate and slender with flowers remote, solitary, cymose or paniculate. Flowers hermaphroditic, zygomorphic, sessile and bracteate.

SECTION 1. VERBENACA Schauer

1. VERBENACA Schauer in DC. Prodr. **11**: 536. 1847.

Sterile style-lobe adjacent to the stigmatic surface or sub-lateral but usually not protruding beyond it; ovary entire at the apex with the style attached at the distal end, or, if at all lobed, style inserted in the indefinite depression between the lobes; schizocarp commonly not constricted along the lines of cleavage; anthers unappendaged. Annuals or herbaceous perennials with prostrate, decumbent-ascending or erect stems. Flowers mostly not showy. Calyx rarely more than twice as long as the schizocarp and not contorted beyond it. Species 1–32.

Ser. I. PACHYSTACHYAE Schauer. Heads or spikes, at least in anthesis, crowded and short, not at any time greatly elongated or open, generally disposed in compound cymes.—Chiefly introduced South American species.

KEY TO THE SPECIES

A. Leaves semiamplexicaul and subcordate.
B. Inflorescence glandular; bracts conspicuously longer than the calyx; corolla-tube 2–3 times as long as the calyx.................... *1. V. rigida*
B. Inflorescence not glandular; bracts barely equalling or only slightly exceeding the calyx; corolla-tube scarcely twice as long as the calyx.... ....*2. V. bonariensis*
A. Leaves not semiamplexicaul nor subcordate, tapering into a cuneate-attenuate subsessile or petiolar base.
C. Spikes short (3–5 mm. long), very dense and appressed-pubescent.
D. Fruiting-calyx ascending; schizocarp longer than broad, raised-reticulate above, striate toward the base............*3. V. brasiliensis*
D. Fruiting-calyx spreading; schizocarp as broad as long, practically smooth...*4. V. sphaerocarpa*
C. Spikes 5–10 mm. long, dense at the apex, somewhat open below and finely strigillose..................................*5. V. litoralis*

1. **V. rigida** Spreng. in L. Syst., Cur. Post. 4^2: 230. 1827.
V. venosa Gill. & Hook. Bot. Misc. **1**: 167. 1830.

V. bonariensis var. *rigida* O. Kuntze, Rev. Gen. 3^2: 255. 1898; Briq. Ann. Conserv. & Jard. Bot. Genève 7–8: 291. 1904.

Stems 2–6 dm. tall, sharply 4-angled in cross-section, scabrous-pubescent; leaves oblong to oblong-lanceolate or narrowly obovate, sessile, more or less semiamplexicaul, subcordate, sharply and coarsely serrate, midrib and veins impressed above but prominently reticulated beneath, scabrous and more or less hispidulous on both surfaces, margins of older leaves somewhat revolute; spikes usually short, dense and cylindrical, disposed in subternate cymes with the laterals pedunculate; bracts lanceolate, acuminate-subulate, usually closely imbricated and longer than the calyx, glandular-pubescent, ciliate; calyx 4 mm. long, glandular-pubescent, lobes acute with short mucronate-subulate tips; corolla-tube twice (–thrice) as long as the calyx, pubescent without; corolla-limb 5–7 mm. broad; stamens inserted on the lower middle of the corolla; nutlets trigonous, slightly broader at the base than at the apex, scarcely 2 mm. long, raised-reticulate on the upper half, striate toward the base; commissural faces muricately scabrous.

Distribution: indigenous to South America; introduced in the West Indies and southern United States.

Specimens examined:

North Carolina: roadside, Williamston, Martin Co., 4 July 1922, *Randolph 688* (G).

Georgia: uncultivated ground, in perennial spreading patches, 26 May 1928, *Reade* (NY); vicinity of Thomson, McDuffie Co., 1 Sept. 1907, *Bartlett 1122* (P).

Alabama: Mobile, *Mohr* (US); Mobile, June 1919, *Graves 525* (MBG, US).

Louisiana: Mandeville, 15 Aug. 1912, *Pennell 4204* (NY); Covington, Aug. 1919, *Arsène* (US); Catalpa, 24 Aug. 1912, *Pennell 4332* (NY); Baton Rouge, 28 March 1904, *Billings 49* (G); roadsides, Plaquemines Co., July 1883, *Langlois* (NY).

Texas: Orange, 1914, *Young 662* (P, US); Huntsville, 24 May 1917, *E. J. Palmer 12038* (MBG); Houston, 1872, *Hall 433* (G, MBG, NY, P, US); Houston, 1913, *Fisher 460, 625* (US); Houston, 25 Sept. 1915, *Thurow* (US); Houston, 22 May 1917, *E. J. Palmer 12001* (MBG); 16 km. southeast of Houston, 12 April 1925, *Small & Wherry 11813* (NY).

Mexico: Vera Cruz: Zacuapan, May 1913, *Purpus 6413* (F, G, MBG, NY, US).

West Indies:

Bermuda: St. George's, 13 July 1905, *Moore 2984* (G); near Devil's Hole, 13 June 1905, *Harshberger* (ANSP, G, MBG); near Hamilton, 31 Aug.–21 Sept. 1905, *Brown & Britton 153* (ANSP); Tucker's Town, 3 May 1912, *Collins 45* (G); Tucker's Town, 8 Aug. 1913, *Collins 269* (G, NY); fields, Montrose, Sept. 1913, *Brown, Britton & Wortley 1645* (ANSP, NY); St. David's Island, 22 May–2 June 1919, *Brown 693* (ANSP, NY).

CUBA: near Farallones, Oriente, 5 Aug. 1913, *Leon 3910* (NY).

JAMAICA: road to Salt Hill, St. Andrew, 6 May 1915, *Harris 11969* (G, MBG, NY); Blue Mountains, St. Andrew, 20 March 1916, *Perkins 1024* (G); near Fairfield, 3–7 Sept. 1908, *Britton 3176* (NY).

GUADELOUPE: without locality, 1893, *Duss 3470* (NY).

MARTINIQUE: without locality, Sept. 1901, *Duss 4697* (NY).

This South American species is commonly cultivated. It has escaped and established itself in various places. Kuntze and Briquet have regarded it as a variety of *V. bonariensis*, but lacking a considerable amount of material for examination, the writer prefers, at present, to maintain it as a specific entity.

2. **V. bonariensis** L. Sp. Pl. 20. 1753.

V. elongata Salisb. Prodr. 71. 1796.

?*V. quadrangularis* Vellozo, Fl. Flum. 16. 1825; 1: *pl. 39.* 1827.

Stems 1 m more or less in height, 4-angled in cross-section, somewhat scabrous-pubescent; leaves decussately opposite, lanceolate, subauriculate, semiamplexicaul, acutely serrate, entire toward the base, rugose and hirtellous above, spreading-pubescent beneath, particularly along the prominently reticulated veins; spikes compact, mostly short, commonly sessile and crowded in dense fasciculate cymes; bracts lanceolate-acuminate, barely equalling or slightly exceeding the calyx, pubescent; calyx 3 mm. long, pubescent, lobes acute with short subulate tips; corolla-tube scarcely twice the length of the calyx, pubescent without; corolla-limb inconspicuous; nutlets 2 mm. long, trigonous, chiefly striate, slightly raised-reticulate at apex; commissural faces scarcely reaching the tip of the nutlet, muricate-scabrous.

Distribution: native of South America; introduced into southern United States and the West Indies.

Specimens examined:

SOUTH CAROLINA: roadsides near Charleston, *Curtiss 1963* in part (F, G, MBG, NY); Charleston Neck, 28 Sept. 1853, *Gibbes* (NY, US); Charleston, 30 April 1912, *Robinson 127* (G); about 6 km. south of Charleston, 9 Nov. 1929, *Moldenke 148* (MBG, NY).

GEORGIA: along canal bank, Augusta, *Cuthbert 267, 358* (NY).

LOUISIANA: vicinity of Covington, 1920, *Arsène 11859, 12534* (F, US).

ARKANSAS: roadsides near Forrest City, 17 Oct. 1925, *E. J. Palmer 29303* (G, MBG, NY).

TEXAS: Huntington, 15 Sept. 1923, *Tharp 2558* (US).

WEST INDIES:

BERMUDA: waste ground, 29 March–3 May 1909, *Marble 737* (ANSP, NY); Pem-

broke Swamp, 21 June 1905, *Harshberger* (ANSP, G, MBG, NY); roadside, Pembroke, 31 Aug.–20 Sept. 1905, *Brown & Britton 98* (ANSP, G, NY, P); Hamilton, 12 July 1905, *Moore 2946* (G); Hamilton, 16 Jan. 1912, *Robinson 94* (G); Tucker's Town, *Collins 53* (G), *266* (G, NY).

JAMAICA: Blue Mountains, 14 Jan. 1890, *Hitchcock* (MBG); Blue Mountains, Mt. Hybla, 5 Apr. 1916, *Perkins 102* (G); St. Helen's Gap, 7 April 1909, *Taylor 4244* (NY); St. Helen's Gap, St. Andrew, 4 March 1920, *Maxon & Killip 569* (G, NY); Cinchona, 26 July 1903, *Nichols 163* (G, MBG, NY); Cinchona, 22 Dec. 1905, *Harris 9132* (NY); Arntully, 25 Aug. 1927, *Orcutt 2736* (G, MBG).

This is another introduced South American species evidently related to *V. rigida*, but it is a larger and coarser plant with smaller flowers as well as less harsh and somewhat viscid pubescence.

3. **V. brasiliensis** Vellozo, Fl. Flum. 17. 1825; 1: *pl. 40.* 1827.
V. litoralis var. *brasiliensis* Briq. Ann. Conserv. & Jard. Bot. Genève 7–8: 292. 1904.

Stems 1 m. more or less in height, 4-angled in cross-section, practically glabrous below, somewhat scabrous-pubescent above, slightly contracted at the nodes; leaves decussate, lanceolate, tapering into a cuneate-attenuate, subsessile or petiolar base, sharply or incised serrate, strigillose and somewhat pustulate above with veins impressed, sparsely pubescent beneath; spikes compact, mostly short and strict, usually sessile in open cymes; bracts scarcely as long as the calyx, lanceolate, subulate at apex, ciliate; calyx approximately 3 mm. long, somewhat appressed-pubescent, lobes acute with short subulate tips; corolla-tube a little longer than the calyx, pubescent without; corolla-limb inconspicuous; nutlets trigonous, about 2 mm. long, strongly striate, raised-reticulate at apex; commissural faces scarcely reaching the tip of the nutlet, muricate-scabrous.

Distribution: South America; introduced into southern United States.

Specimens examined:

NORTH CAROLINA: ballast dumps at Wilmington, 2 July 1897, *Small 5707* (G, MBG, NY); dry sandy soil, open woods about 3 km. south of Wilmington, 25 July 1922, *Randolph 1004* (G).

GEORGIA: savanna, 27 May 1927, *Korthoff* (US); Brunswick, 12 May 1930, *Moldenke 1184* (MBG, NY).

FLORIDA: waste place, Chipley, 24 May 1930, *Blanton 6598* (MBG, US); waste ground, Pensacola, 24 July 1899, *Curtiss 6490* (G, MBG, NY, US); ballast ground, Pensacola, 30 April 1903, *Tracy 8706* (F, G, MBG, NY, US).

ALABAMA: ballast ground, estuary of Mobile River, 4 July 1893, *Mohr* (US); Port

Eads, 22 Aug. 1900, *Lloyd & Tracy 20* (F, G, MBG, NY, US); north bank, Bayou Terrebonne, Houma, 29 May 1914, *Wurzlow* (NY).

A species very similar in habit to *V. litoralis* but readily distinguished by the difference in inflorescence. The spikes of *V. brasiliensis* are short, compact, sessile, and regularly arranged in open cymes; whereas those of *V. litoralis* are longer, compact or somewhat elongate, peduncled, and arranged in more or less paniculate cymes.

4. **V. sphaerocarpa** Perry,[17] n. sp.

Stems erect, square in cross-section, branched above, glabrous or sparsely scabrous-pubescent; leaves oblong, tapering at the base into a short petiole, 3–6(–10) cm. long, acute, sharply serrate, the upper often entire, scabrous-pubescent above with trichomes minutely bulbous at the bases, more or less short-strigillose on both surfaces, prominently veined beneath; spikes short and dense, subsessile or short-pedunculate, cymosely arranged; bracts ovate-lanceolate, shorter than the calyx, acute, pubescent; calyx scarcely 2 mm. long, connivent over the schizocarp, appressed-pubescent, teeth very short, acutish; corolla-tube protruding slightly beyond the calyx; corolla-limb about 1.5–2 mm. broad; schizocarp 1 mm. long, approximately 1 mm. in diameter; nutlets very faintly striate or essentially smooth; commissural faces muriculately scabrous.

Distribution: known only from Socorro Island.

Specimens examined:

Mexico: Colima: Socorro Island: March–June 1897, *Anthony 380* (G, MBG type, US); 27 May–3 July 1903, *Barkelew 231* (G, MBG, P, US); 9 May 1925, *Solis 70* (US).

This endemic from Socorro Island is most nearly related to *V.*

[17] **V. sphaerocarpa** Perry, sp. nov., annua vel perennis (basi ignota); caule erecto quadrangulari glabro vel sparse scabro-pubescente; foliis oblongis basi in brevem petiolum attenuatis 3–6(–10) cm. longis acutis, infimis argute serratis, superioribus saepe integris, omnibus scabro-pubescentibus supra subtusque plus minusve breviter strigosis et reticulatis; spicis brevibus et compactis subsessilibus vel breviter pedunculatis in cymas dispositis; bracteis ovato-lanceolatis acutis pubescentibus calyce brevioribus; calyce vix 2 mm. longo connivente adpresso-pubescente; calycis dentibus brevissimis acutiusculis; corollae tubo paulo exserto; corollae limbo circiter 1.5–2 mm. lato; schizocarpio 1 mm. alto circiter 1 mm. lato; coccis obsolete striato-reticulatis.—Collected on Socorro Island, Mexico, March–June 1897, *Anthony 380* (MBG), type.

litoralis and has a similar habit, but is easily separated on the distinctive characters of the inflorescence. The spikes are shorter and denser, the flowers are smaller and so crowded that the lower ones appear to be inserted at right angles to the rhachis of the spike; moreover, the schizocarp is fully as broad as or even broader than long, an unusual trait not found elsewhere in the North American species of *Verbena.*

5. **V. litoralis** HBK. Nov. Gen. et Sp. **2**: 276, *pl. 137.* 1818.

V. caracasana HBK. *l. c.* 275.

V. bonariensis var. *littoralis* Hook. Bot. Misc. **1**: 166. 1830.

V. affinis Mart. & Gal. Bull. Acad. Brux. **11**²: 322. 1844.

V. littoralis α *pycnostachya* Schauer in DC. Prodr. **11**: 542. 1847, excluding *V. brasiliensis* Vell. Fl. Flum. **1**: *pl. 40.*

V. littoralis β *leptostachya* Schauer in DC. Prodr. *l. c.*

V. Hanseni Greene, Pittonia **3**: 308. 1898.

V. litoralis var. *caracasana* Briq. Ann. Conserv. & Jard. Bot. Genève 7–8: 292. 1904.

Stems approaching 1 m. in height, square in cross-section, somewhat fastigiately branched above, glabrous or sparsely strigillose, slightly contracted at the nodes; leaves lanceolate or oblong, tapering into a very short petiole or a subsessile base, 3–10 cm. long, decussate, more or less sharply and coarsely serrate, sparsely strigillose on both surfaces, scabrous and somewhat rugose above, prominently veined beneath; spikes terminal, fairly dense, pedunculate, cymosely arranged or tending to be panicled, often elongate; bracts ovate-lanceolate, acuminate, subequalling or somewhat shorter than the calyx, glabrate; calyx 2–2.5 mm. long, finely strigillose, subtruncate, teeth minute, subulate; corolla-tube variable in length, always somewhat longer than the calyx; corolla-limb inconspicuous, 2.5–3 mm. broad; nutlets trigonous, hardly 2 mm. long, striate, somewhat reticulate at the apex; commissural faces about as long as the nutlet, muricate-scabrous.

Distribution: Mexico, Central and South America; introduced into the United States.

Specimens examined:

Louisiana: north bank, Bayou Black, Houma, 5 and 9 May 1914, *Wurzlow* (NY).

California: Clinton, Amador Co., June 1896, *Hansen 2025* (MBG).

Mexico:

San Luis Potosi: on mountains around the city, San Luis Potosi, 1876, *Schaffner 718* (G); Alvarez, 28 Sept.–3 Oct. 1902, *Palmer 141* in part (G).

Nayarit: Tepic, 5 Jan.–6 Feb. 1882, *Palmer 2019* (US), *2014a* (G, NY).

Jalisco: fields, Guadalajara, 11 Aug. 1902, *Pringle 11093* (F, G, MBG, NY, US).

Hidalgo: near Ixmiquilpan, 1905, *Rose, Painter & Rose 9077, 9151* (US).

Vera Cruz: Orizaba, 27 July 1891, *Seaton 27* (F, G, NY, US); Huatusco, April 1857, *Mohr* (US); Fortin, Feb. 1883, *Kerber 311* (US); Santa Rosa, 13 Aug. 1926, *Fisher 168* (US).

Tabasco: Mayito, 10 April 1889, *Rovirosa* (ANSP, NY, US).

Puebla: Pahuatlan, 14 June 1913, *Salazar* (US); near Puebla, 20 Oct. 1908, *Arsène* (US).

Michoacan: low valley, Zinapecuaro, 2 May 1849, *Gregg 764* (MBG); Quinceo, 11 Nov. 1909, *Arsène* (US); Morelia, Aug.–April 1840, *Galeotti 781* (K), type collection of *V. affinis;* Morelia, Coronilla, 8 Aug. 1909, *Arsène* (US).

Oaxaca: wet meadows, Sierra de San Felipe, 11 Sept. 1894, *Pringle 4877* (ANSP, G, MBG, NY, P, US); Sierra de San Felipe, 6 Oct. 1894, *C. L. Smith 222* (MBG, US); San Jacinto, 25 Sept. 1895, *L. C. Smith 794* (G).

Central America:

Guatemala: uncultivated places, Oct. 1885, *Bernoulli 128* (NY); without locality, 1892, *Heyde 610* (US); waste places near railway bridge, 5 June 1909, *Deam 6180* (G, US); vicinity of Los Amates, Dept. Izabal, 24 May 1922, *Standley 24404* (US); Coban, Dept. Alta Verapaz, May 1886, *von Tuerckheim 904* (ANSP, F, G, NY, US); near the Finca Sepacuite, Dept. Alta Verapaz, 25 March 1902, *Cook & Griggs 148* (US); Canjutz, Dept. San Marcos, 1 Sept. 1922, *Salas 32* (US); Guatemala, 1923, *Ruano 332, 403* (US); Guatemala City, 1912, *Aguirre 4* (US); near Guatemala, July 1921, *Tonduz 627* (US); Chiapas, Dept. Santa Rosa, Dec. 1892, *Heyde & Lux 4370* (G, NY, US); Santa Rosa, May 1892, *Heyde & Lux 3019* in part (G).

Honduras: vicinity of Siguatepeque, Dept. Comayagua, *Standley 56082* (F, US).

San Salvador: vicinity of Ateos, Dept. La Libertad, 17 April 1922, *Standley 23326* (G, US); Volcan de San Vicente, Dept. San Vicente, 7-8 March 1922, *Standley 21486* (G, NY, US); Cerro de San Jacinto, near San Salvador, 8 Feb. 1922, *Standley 20617* (G, US); San Jacinto, 5 April 1905, *Velasco 8848* (G, US); Volcan de San Salvador, 7 April 1922, *Standley 22842* (US); vicinity of San Salvador, 1905, *Renson 291* (NY, US); San Salvador, 1922, *Calderon 729* (G, NY, US), *925* (G, US).

Nicaragua: Casa Colorada and vicinity, south of Managua, 27 June 1923, *Maxon, Harvey & Valentine 7356* (NY, US); Las Nubes and vicinity, south of Managua, 28 June 1923, *Maxon, Harvey & Valentine 7478* (US).

Costa Rica: without locality, 19 June 1874, *Kuntze 2109* (NY, US); without locality, April 1910, *Worthen* (MBG); Los Ayotes, near Tilaran, Prov. Guanacaste, 21 Jan. 1926, *Standley & Valerio 45430* (US); Aguacate, Nov. 1846, *Oersted 11322* (US); vicinity of San Jose, Feb. 1924, *Standley 33293* (US); vicinity of La Palma, on the road to La Hondura, 17–18 July 1923, *Maxon & Harvey 7951* (US); Cerro de Piedra Blanca, above Escasu, 31 Jan. 1924, *Standley 32652* (US); near Cartago, 1845–8, *Oersted 11324* (US); Cartago, Oct. 1887, *Cooper 5890* (F, G, MBG, NY, US).

Panama: fields along Rio Caldera above El Boquete, 5 Feb. 1918, *Killip 3510* (US).

This is a widely distributed species with very distinctive habit and somewhat variable inflorescence. In some specimens the

spikes appear to remain compact, in others they tend to elongate. Schauer used this difference to separate the forms *pycnostachya* and *leptostachya*, although he frankly admits the difficulty of distinguishing the two owing to the intermediate phases. *V. affinis* is characterized by a somewhat coarser floral pubescence; this, however, seems to be a variable feature and, as such, does not appear to merit more than passing mention.

Ser. II. LEPTOSTACHYAE Schauer. Spikes slender and open or compact at anthesis, greatly elongating in fruit, solitary or in simple cymes or panicled.—North America.

Key to the Species

A. Spikes panicled at the apices of stems and branches, subtended chiefly by inconspicuous bracts; floral bracts not prominent.
  B. Spikes very slender, elongated and graceful, usually with remote fruits.
    C. Leaves 1–2-pinnatifid or 3–5-cleft or deeply incised.
      D. Corolla-limb not less than 3 mm. broad; nutlets 1.5 mm. or more long.
        E. Schizocarp a little longer than broad.
          F. Inflorescence usually densely glandular and somewhat viscid-pubescent .... *6. V. officinalis*
          F. Inflorescence sparsely, if at all, glandular and strigillose .... *7. V. menthaefolia*
        E. Schizocarp about twice as long as broad.
          G. Leaf-blades diverse in outline, the basal incised-dentate, the middle stem-leaves 1–2-pinnatifid, the upper sparingly toothed or entire; bracts one-half as long as the calyces at anthesis .... *8. V. Halei*
          G. Leaf-blades similar in outline; bracts about as long as the calyces at anthesis .... *9. V. riparia*
      D. Corolla-limb scarcely more than 1 mm. broad; nutlets 1.5 mm. or less long .... *10. V. Ehrenbergiana*
    C. Leaves serrate or shallowly incised.
      H. Leaves subsessile or short-petioled with attenuate base.
        I. Stems hirsute-hispid; leaves mostly crenate-serrate; calyx hispidulous .... *11. V. carolina*
        I. Stems glabrous; leaves acutely serrate; calyx practically glabrous .... *13. V. longifolia*
      H. Leaves obviously petioled with rounded-cuneate base.
        J. Fruiting-calyx spreading; calyx-lobes connivent; stigmatic surface subtended by two sterile style-lobes .... *14. V. scabra*
        J. Fruiting-calyx ascending; calyx-lobes not connivent; stigmatic surface subtended by one sterile style-lobe .... *15. V. urticifolia*
  B. Spikes thicker or densely flowered, usually with contiguous fruits.

K. Spikes subsessile or very short-peduncled, forming a congested inflorescence, not strict; corolla-limb 2 mm. broad..............*12. V. recta*

K. Spikes peduncled, usually not congested, strict; corolla-limb 3–4.5 mm. broad..*16. V. hastata*

A. Spikes solitary or in 3's at the apices of stem and branches, or panicled and subtended by leafy bracts at the base; floral bracts prominent or not.

L. Schizocarp readily separating into 4 nutlets at maturity.

M. Leaves serrate-dentate or shallowly incised, or predominantly entire.

N. Leaves serrate or serrate-dentate or shallowly incised; spikes with more or less contiguous fruits.

O. Plants coarse, more or less densely hirsute-pubescent or hirsute-villous; leaves elongate-elliptical to ovate-orbicular; spikes stout at anthesis, 7–10 mm. broad.

P. Leaves elongate-elliptical to ovate-acuminate, short-petiolate; corolla-limb 5–6 mm. broad.

Q. Plants hirsute-hispidulous; spikes flexuous, elongated and open in fruit; bracts not exceeding the fruiting calyx; nutlets 2 mm. long, shallowly scrobiculate above, sulcate toward the base..........................*21. V. macrodonta*

Q. Plants hirsute-pubescent; spike strict, dense in fruit; bracts surpassing the fruiting calyx; nutlets 2.5 mm. long, reticulate-scrobiculate above, striate toward the base.................................... ...*20. V. MacDougalii*

P. Leaves ovate-orbicular, sessile; corolla-limb 8–9 mm. broad.. ....*19. V. stricta*

O. Plants more slender, hirtellous or sparsely strigillose with short trichomes, canescent or not; leaves linear to narrowly elliptical or spathulate; spikes at anthesis 5–6 mm. broad.

R. Leaves strigillose; inflorescence not glandular-pubescent.... ....*17. V. simplex*

R. Leaves hirtellous; inflorescence glandular-pubescent.

S. Leaves hirtellous; rhachis more or less angulate; bracts lanceolate-acuminate; corolla-limb 3–4 mm. broad...*18. V. Orcuttiana*

S. Leaves hirtellous and canescent; rhachis scarcely angulate; bracts ovate-acuminate; corolla-limb 6–8 mm. broad.... ....*26b. V. neomexicana* var. *hirtella*

N. Leaves predominantly entire (mostly linear, the lower ones with a few salient teeth); spikes with more or less remote fruits..*27. V. perennis*

M. Leaves deeply incised-dentate or pinnatifid or 3-cleft.

T. Spikes not essentially bracteose; flowers readily seen; corolla-limb 4–10 mm. broad.

U. Leaf-blades, at least the lower ones, oblong-ovate or obtusely elliptic-ovate, not narrowly elongated, usually 3-cleft with the segments incised-dentate.

V. Leaves petioled; pubescence various, but not coarsely hirsute; spikes usually stout, if slender not greatly elongated.

W. Leaves not plicate, venation not noticeably whitish near the margin; spikes stout at anthesis, elongating or not in fruit.

X. Plants pilose to hirsute-villous; leaves not scabrous above; spikes elongating in fruit; bracts not exceeding the calyx.................................*22. V. prostrata*

X. Plants sparsely hirsute; leaves scabrous above; spikes occasionally elongating in fruit; bracts slightly surpassing the calyx............................*23. V. robusta*

W. Leaves more or less strongly plicate; venation noticeably whitish near the margin; spikes not stout at anthesis.... ....*25. V. plicata*

V. Leaves subsessile or at most very short-petioled; pubescence coarsely hirsute; spikes slender and greatly elongated..*24. V. xutha*

U. Leaf-blades, at least the lower ones, oblong-lanceolate to spathulate, narrowly elongated, usually incised-pinnatifid or incised-dentate (excl. *V. plicata*).

Y. Plants coarse with a low somewhat compact habit. canescent-hirsute; leaves subpinnatifid, contracted into a broadly margined semiamplexicaul or petiolar base.

Z. Inflorescence somewhat glandular-hirsute; bracts lanceolate. ....*29. V. canescens*

Z. Inflorescence sparsely, if at all, glandular and densely hirsute; bracts ovate, abruptly acuminate..................... ....*29a. V. canescens* var. *Roemeriana*

Y. Plants more slender with a taller and open habit, hirsute to canescent-hirtellous; leaves .pinnately cleft to incised-dentate, with a narrowly margined petiolar base.

AA. Corolla-limb 4 mm. broad; commissural faces extending to the tip of the nutlet...*26. V. neomexicana*

AA. Corolla-limb 6–10 mm. broad; commissural faces scarcely extending to the tip of the nutlet.

BB. Plant more or less hirsute; leaves pinnately cleft; bracts lanceolate.. ....*26a. V. neomexicana* var. *xylopoda*

BB. Plants canescent-hirtellous; leaves dentate or somewhat more deeply incised; bracts ovate.................*26b. V. neomexicana* var. *hirtella*

T. Spikes usually bracteose with somewhat foliaceous bracts at the base of the spike; flowers inconspicuous; corolla-limb 2.5–3 mm. broad (larger in *V. plicata*).

CC. Plants delicate; leaves incised-pinnatifid to pinnately cleft, not plicate; inflorescence glandular-hirtellous; nutlets 1.5–2 mm. long, scrobiculate practically to the base....................*28. V. gracilis*

CC. Plants coarse; leaves incised-dentate to subpinnatifid or 3-cleft, plicate or not; inflorescence hirsute or pubescent-hirsute; nutlets 2–2.5 mm. long, not scrobiculate to the base.

DD. Leaves more or less strongly plicate, conspicuously whitish-veined near the margin...........................*25. V. plicata*

DD. Leaves not plicate nor conspicuously whitish-veined near the margin.

EE. Plants hirsute; leaves spreading-hirsute; nutlets raised-reticulate above, striate below.

FF. Leaves with a subpetiolar or semiamplexicaul base; bracts

ovate (a little longer than the flowers), abruptly acuminate, ascending..............*29a. V. canescens* var. *Roemeriana*

FF. Leaves narrowed into a margined petiole; bracts linear-lanceolate (much longer than the flowers), usually reflexed in age................................*31. V. bracteata*

EE. Plants hirsute-pubescent; leaves appressed-hirsute; nutlets only faintly reticulate or essentially smooth......*30. V. subuligera*

L. Schizocarp tardily separating into 4 nutlets at maturity..........*32. V. carnea*

6. V. officinalis L. Sp. Pl. 20. 1753.

V. spuria L. *l.c.*

V. domingensis Urb. Symb. Ant. 5: 484. 1908.

Stems ascending or erect, branched, glabrous or nearly so; leaves 2–7 cm. long, strigillose on both surfaces; basal and lower stem-leaves more or less ovate, narrowed below into a petiole, 1–2-pinnatifid or 3–5-cleft with parts incised; upper leaves similar but smaller and less divided; spikes paniculately disposed or in 3's or solitary, slender and elongate; bracts usually about half as long as the calyx; calyx 2–2.5 mm. long, glandular-pubescent, subtruncate, teeth minute; corolla-tube a little longer than the calyx; corolla-limb about 4 mm. broad, segments more or less rounded; nutlets trigonous, barely 2 mm. long, strongly striate, slightly reticulate above; commissural faces muricate.

Distribution: Europe; introduced in waste places in eastern North America and West Indies.

Specimens examined:

MASSACHUSETTS: Rowley, *Oakes* (G).

RHODE ISLAND: Warwick Neck, 1848, *Thurber* (G).

NEW YORK: Brooklyn, 13 Sept. 1879, *von Schrenk* (MBG).

NEW JERSEY: ballast, Camden, 30 Aug. 1874, *Parker* (G); roadside, Longacoming, Camden Co., 23 July 1867, *Parker* (G); Cold Spring, Cape May Co., 30 Aug. 1917, *Gershoy 583* (G).

PENNSYLVANIA: Philadelphia, 1844, *Lea* (MBG); Lancaster, 21 Aug. 1861, *Porter* (G); banks of Susquehanna, Harrisburg, Oct. 1852, *Porter* (G); York Furnace, York Co., 28 June 1899, *MacElwee 873* (MBG).

DELAWARE: Wilmington, 1845, *Tatnall* (G).

DISTRICT OF COLUMBIA: vicinity of Washington, 23 June 1878, *Ward* (MBG).

VIRGINIA: Parksley, 11 Sept. 1902, *Norton* (MBG); Bedford Co., 30 June 1870, *Curtiss* (MBG); Marion, 1892, *Small* (MBG).

NORTH CAROLINA: without data, *Curtis* (MBG); waste grounds, Moyock, 1 July 1922, *Randolph 587* (G); dry sandy bank about 3 km. west of Plymouth, 4 July 1922, *Randolph 645* (G); Clarkton, 23 June 1897, *Biltmore Herbarium 4762* (G, NY); Cranberry Forge, July 1895, *F. Wislizenus 1214* (MBG).

SOUTH CAROLINA: streets in Graniteville, 23 May 1899, *Eggert* (MBG).

GEORGIA: Rome, *Chapman* (MBG).

FLORIDA: without data, *Rugel 121* (F, MBG).

ALABAMA: Collinsville, 29 July 1897, *Eggert* (MBG); Attalla, 9 July 1898, *Eggert* (MBG).

LOUISIANA: Port Eads, 22 Aug. 1900, *Tracy & Lloyd* (G, MBG, NY).

TENNESSEE: along the banks of Doe River, Carter Co., 16–17 July 1891, *Small & Heller 484* (G, MBG); Knoxville, July 1893, *Ruth* (MBG); Hollow Rock, Carroll Co., 5 Aug. 1897, *Eggert* (F, MBG).

WEST INDIES:

BERMUDA: Hamilton Parish, 11 July 1905, *Moore 2939a* (G); Flatts, 31 Aug.–20 Sept. 1905, *Brown & Britton 28* (ANSP, G, NY); Flatts, 3 Aug. 1915, *Collins 267* (G, NY); Bailey's Bay, 10 Feb.–9 March 1908, *Brown 492* (ANSP, G, NY); St. George's, 18 Jan. 1912, *Robinson 113* (G).

SANTO DOMINGO: Angostura del Rio Yaqui, 8 May 1887, *Eggers 1828* (NY), TYPE collection of *V. domingensis;* Culo de Maco, Prov. Azua, Aug. 1912, *Fuertes 1856* (NY); Loma Rosilla, Prov. de la Vega, July 1912, *Fuertes 1771* (NY); vicinity of Mission, Fonds Varettes, 12 April–4 May 1920, *Leonard 3939* (G, NY).

CUBA: without data, *Wright 3658* (G); Vecindad de Vento, May 1906, *Baker 2591* (NY, P); Playa de Marianao, 29 March 1911, *Britton & Cowell 10326* (NY); near Playa de Marianao, *Leon* (NY), *Leon & Edmunds* (NY); cultivated field, Campo Florido, Prov. Havana, 13 March 1905, *Curtiss 677* (ANSP, G, MBG, NY).

On the whole, the specimens from Santo Domingo and Cuba differ from the typical *V. officinalis* in their slender and more elongate habit; the inflorescence is scarcely as glandular, the flowers are smaller, and the nutlets often do not exceed 1.5 mm. in length. Nevertheless, the Cuban specimens vary greatly in size, and *Curtiss 677* is hardly separable from typical *V. officinalis.* Since many of the specimens are rather poor, it appears probable that they may very well represent an impoverished condition. Urban himself was somewhat uncertain of the status of his species as he appended the following note in a later publication: "An re vera a formis V. officinalis L. separanda?"

7. **V. menthaefolia** Benth. Pl. Hartw. 21. 1839.

V. setosa Mart. & Gal. Bull. Acad. Brux. 11^2: 321. 1844.

Stems decumbent or ascending, branched, sparsely and minutely hispidulous; leaves ovate, tapering at base into a margined petiole, 3–6 cm. long, deeply cleft or subincised with divisions remotely serrate-dentate, strigillose on both surfaces, somewhat pustulate above; spikes panicled, slender, elongate, compact only at the apex; bracts ovate-lanceolate, acuminate, variable in length, usually shorter than the calyx, ciliate and sparsely strigillose; calyx 2.5–3 mm. long, strigillose, sparsely (if at all) glandular, teeth minute; corolla-tube only slightly longer

than the calyx; corolla-limb about 6 mm. broad, segments more or less truncate; nutlets trigonous with convex back, 2–2.5 mm. long, striate, raised-reticulate above; commissural faces muricate.

Distribution: Arizona to southern California, northwest Mexico to Oaxaca.

Specimens examined:

ARIZONA: north of Yuma, 26 April 1906, *Jones* (P).

CALIFORNIA: San Diego, May 1852, *Thurber 555* (G), June 1875, *Palmer 308* (MBG), 5 May 1903, *Abrams 3406* (G, MBG, NY, P), 6 July 1915, *Macbride & Payson 781* (G), 17 April 1918, *Carlson* (G), in canyons, Aug. 1918, *Spencer 971* (G, P), waysides, 31 Oct. 1919, *Spencer 1414* (G, P); Otay Creek, San Diego Co., 27 March 1923, *Peirson 3379* (P).

MEXICO:

LOWER CALIFORNIA: Salton River Crossing, 27 April 1894, *Schoenfeldt 2915* (G, NY, US); sandy roadside, Tia Juana, 1 Feb. 1920, *Bartram* (ANSP); ranch, 46 km. southwest of Tia Juana, 13 April 1925, *Jones* (P); base of Cucopa Mountains, 6 April 1905, *MacDougal 153* (NY).

SONORA: vicinity of Alamos, 16 March 1910, *Rose, Standley & Russell 12934* (US); vicinity of Hermosillo, 6 March 1910, *Rose, Standley & Russell 12451* (US); vicinity of Navojoa, 21 March 1910, *Rose, Standley & Russell 13130* (US).

SINALOA: collection of 1921, *Ortega 4215* (US); vicinity of Fuerte, 25 March 1910, *Rose, Standley & Russell 13447* (US); vicinity of San Blas, 24 March 1910, *Rose, Standley & Russell 13422* (NY, US); Topolobampo, 15–25 Sept. 1897, *Palmer 268* (US); near Plomosas, 18 July 1897, *Rose 1763* (US).

CHIHUAHUA: valley of the San Pedro, Ortiz, 11 April 1887, *Pringle 1599* (MBG).

COAHUILA: near Saltillo, 7 May 1848, *Gregg 11* (MBG); near Saltillo, 14 July 1848, *Gregg 265* (G, MBG); vicinity of Saltillo, May 1898, *Palmer 191* (G, MBG, NY, US); vicinity of Buena Vista, 24 July 1848, *Gregg 276* (MBG); valley of Parras, 11 April 1847, *Gregg 406* (MBG, NY); San Lorenzo de Laguna, about 120 km. southwest of Parras, 1–10 May 1880, *Palmer 1042* (ANSP, G, US).

DURANGO: near El Salto, 12 July 1898, *Nelson 4577* (MBG, US); bottom-lands and ravines, Durango, April–Nov. 1896, *Palmer 153* (F, G, MBG, NY, US), *356* (G, MBG, NY, US).

SAN LUIS POTOSI: Alvarez, 28 Feb.–3 Oct. 1902, *Palmer 141* in part (F, G, MBG, NY, US); San Luis Potosi, 1878, *Parry & Palmer 717* (G).

AGUASCALIENTES: near Aguas Calientes, 10 Oct. 1903, *Rose & Painter 7799* (US).

GUANAJUATO: margin of stream, Sirena Mountain, 1894, *Duges* (G); Leon, 1839, *Hartweg 175* (K TYPE, NY).

QUERETARO: vicinity of Queretaro, 1912, *Basile 99* (US); Queretaro, 1910–13, *Arsène & Agniel 10242* (F, G, MBG, US); Queretaro, July 1914, *Arsène 9998* (US).

VERA CRUZ: Maltrata, 20 Aug. 1891, *Seaton 7* (F, G, US); Huatusco, 1857, *Mohr* (US).

HIDALGO: Sierra de Pachuca, 20–24 July 1905, *Rose, Painter & Rose 8753* (G, NY, US); Nopala, Aug. 1913, *Salazar* (US); Moran, 1840, *Galeotti 778* (K), TYPE collection of *V. setosa.*

MEXICO: near Tlalnepantla, 6 July 1905, *Rose, Painter & Rose 8382* (G, US); Lomas de Santa Fe, July 1928, *Lyonnet* (US); Valley of Mexico, 1865–66, *Bourgeau 360* (US), *547* (G); Valley of Mexico, 27 June 1901, *Pringle 8534* (ANSP, F, G, MBG,

NY, P, US); mountains between Toluca and Mexico City, 28 June 1910, *Rusby 181* (NY).

MORELOS: La Cascada, 29 May 1901, *Pringle 9529* in part (F, US).

MICHOACAN: Morelia-Rincon, *Arsène 2798* (G); east of Maravatio, 30 April 1844, *Gregg 823* (MBG).

OAXACA: mountains, San Juan del Estado, 18 June 1894, *L. C. Smith 27* (G); Sierra de San Felipe, 20 Aug. 1894, *Pringle 5715* (G); between Coixtlahuaca and Tamazulapam, 12 Nov. 1894, *Nelson 1943* (US); between Las Sedas and Salome, 30 Aug. 1921, *Conzatti 4207* (US).

In the specimens cited from California south including Sinaloa, the inflorescence is more densely strigillose than in the collections from the southern part of Mexico, the calyces are about 1 mm. longer, with teeth strongly unequal and the subtending bracts often as long as the calyces. Although this apparently indigenous species has been known generally as *V. officinalis*, it has somewhat harsher pubescence and is scarcely, if at all, glandular. The fruiting calyx tends to be connivent, concealing the apex of the schizocarp rather than open and disclosing it. Perhaps these are differences only of degree and may be merely variations of *V. officinalis;* nevertheless, for the present it seems preferable to retain the name *V. menthaefolia* for the American representative.

8. **V. Halei** Small, Bull. Torr. Bot. Club 25: 617. 1898.

V. leucanthemifolia Greene, Pittonia 5: 135. 1903.

Stems usually several from a woody base, erect, ascendingly branched, glabrous or strigillose above; leaves 3–10 cm. long, strigillose on both surfaces, diverse in outline—the basal and lower stem-leaves oblong to ovate, tapering into a petiole approximately as long as the blade, irregularly dentate or incised; the middle stem-leaves 1–2-pinnatifid with shorter petioles; the upper sparingly dentate or entire; spikes paniculately disposed, slender and elongate; bracts about one-half as long as the calyx, appressed, ciliate; fruiting calyx 3–3.5 mm. long, strigillose, subtruncate, the broad nerves terminating in unequal subulate teeth; corolla-tube scarcely longer than the calyx; corolla-limb 6–7 mm. broad, segments retuse; nutlets trigonous, approximately 2.5 mm. long, usually prominently striate, raised-reticulate at apex; commissural faces muricate.

Distribution: Alabama to Texas, Mexico.

ALABAMA: without data, *Buckley* (MBG); Frascati, 11 May 1904, *Deweys* (G).

MISSISSIPPI: cultivated grounds near coast, May 1859, *Hilgard* (MBG); Ocean Springs, 14 Sept. 1891, *Seymour 50* (G); Ocean Springs, June 1892, *Skehan 109* (G, MBG), *46* (G); Biloxi, 9 June 1900, *Tracy* (NY); Natchez, June 1898, *Shimek* (MBG).

LOUISIANA: without data, *Riddell 1268* (NY); without data, *Hale* (G), *245* (NY); sandy open ground, Natchitoches, 24 April 1915, *E. J. Palmer 7369* (MBG); Alexandria, 29 Aug. 1847, *Gregg* (MBG); vicinity of Covington, 1920, *Arsène 11831*, *12242* (US); Gretna, opposite New Orleans, 5 May 1899, *Ball 344* (G, MBG, NY); Madisonville, 14 May 1888, *Joor* (MBG); along Calcasieu River near Lake Charles, 11 April 1925, *Small & Wherry 11774* (NY); Cameron, 4 July 1903, *Tracy 8709* (F, G, MBG, NY); vicinity of Cameron, 4 Dec. 1910, *McAtee 1953* (US).

OKLAHOMA: south of Dougherty, Murray Co., 1 May 1926, *Stratton 62* (MBG).

TEXAS: Texarkana, *Letterman* (MBG); railroad near Polk, 13 June 1898, *Eggert* (MBG); between Iowa Park and Electra, Wichita Co., 20 Aug. 1921, *Ferris & Duncan 3337* (MBG); near Longview, 19 April 1899, *Eggert* (MBG); Dallas, *Reverchon 42* (G), *732* (MBG); Dallas, *Jones* (P); North Dallas, 27 June 1899, *Eggert* (MBG); Brazos, July 1843, *Lindheimer 155 (77)* (MBG); Tarrant Co., *Ruth 108* (G, MBG, NY, US); Van Zandt, April 1929, *Ezell 5699* (US); prairies near Granbury, Hood Co., 4 May 1900, *Eggert* (MBG); Abilene, 19 May 1902, *Tracy 7996* (F, G, MBG, NY); near Comanche, 8 May 1900, *Eggert* (MBG); Waco, 1904, *Pace 22* (MBG); Gurley, 20 April 1907, *Howell 362* (US); San Augustine, 19 April 1916, *E. J. Palmer 9485* (MBG); College Station, Brazos Co., 28 April 1917, *E. J. Palmer 11715* (MBG); Mill Creek, April 1839, *Lindheimer* (MBG); near Houston, March 1842, *Lindheimer 155 (106)* (MBG); prairies, Houston, 1872, *Hall 432* (MBG, P); Houston, 21 April 1899, *Eggert* (MBG); Houston, 17 April 1900, *Bush 28* (MBG, US); Galveston Island, May 1843, *Lindheimer* (MBG); Galveston Island, 22 Sept. 1901, *Tracy 7533* (F, G, MBG, NY); Alvin, 22 April 1918, *Young* (P); Columbia, 9 April 1899, *Bush 84* (G, MBG); Columbia, 20 April 1900, *Bush 77* (G, MBG, NY, US); sandy prairies, Columbia, 29 March 1914, *E. J. Palmer 5044* (MBG); Austin, 1 May 1915, *Young 77* (MBG); Austin, 7 April 1922, *Tharp 2818* (US); flood plains of Colorado River, near Austin, 2 April 1929, *Armer 5385* (US); Crab Apple Creek, Gillespie Co., *Jermy 203* (MBG); Kerrville, 4 June 1916, *E. J. Palmer 10037* (MBG); New Braunfels, April 1851, *Lindheimer 1076 (537)* (G, MBG, NY); near Bracken, 13 July 1903, *Groth 75* (G, NY); Bexar to Austin, April 1828, *Berlandier 322*, *1592* (G); San Antonio, 1900, *Wilkinson* (MBG); San Antonio, 1911, *Clemens & Clemens 969*, *970* (P); San Antonio, April 1922, *Schulz 766* (US); Sutherland Springs, Wilson Co., Aug. 1879, *Palmer 1043* (G); near Sabinal, 21 April 1925, *Small & Wherry 11998* (NY); Del Rio, 20 April 1930, *Jones 26229* in part (P); Uvalde, 11 May 1918, *E. J. Palmer 13564* (MBG); Uvalde, 28 April 1928, *E. J. Palmer 33604* (MBG, NY); Millett, 11 May 1897, *Trelease* (MBG); Cuero, 22 March 1907, *Howell 313* (US); prairies near Goliad, 8 April 1900, *Eggert* (G, MBG); Refugio, 8 March 1916, *E. J. Palmer 9111* (MBG); Corpus Christi, 5–12 March 1894, *Heller 1419* (G, MBG, NY, US); Corpus Christi, 1 May 1913, *Orcutt 5867* (MBG); Kingsville, 25 March 1920, *High 52* (MBG); near Laredo, Aug. 1899, *Mackenzie 96* (MBG); near Laredo, 6 April 1901, *Eggert* (MBG); Rio Hondo, Cameron Co., Sept. 1913, *Chandler* (G, MBG); Sierra Blanca, 11 April 1930, *Jones 26229* in part (MBG).

MEXICO: TAMAULIPAS: Matamoros, *Berlandier 1511*, *3016* (G, MBG); vicinity of Tampico, 1–31 Jan. 1910, *Palmer 78* (F, G, MBG, NY, US).

A species closely related to *V. menthaefolia* and *V. officinalis*,

but readily distinguished by the diverse outline of the leaves and the somewhat more slender achenes.

9. **V. riparia** Raf. ex Small & Heller, Mem. Torr. Bot. Club **3**: 12. 1892.

? *V. hastata* var. β *oblongifolia* Nutt. Gen. **2**: 40. 1818.

V. urticifolia var. *riparia* Britton, Mem. Torr. Bot. Club **5**: 276. 1894.

Stems 6–15 dm. tall, erect, sparsely pubescent or glabrate, widely branched; leaves oblong to ovate, 4–12 cm. long, petioled, pinnatifid or nearly tripartite toward the base, sparsely strigillose on both surfaces, venation prominent beneath; spikes paniculately disposed, slender, elongate; bracts lanceolate-ovate, as long as the calyx at anthesis, acuminate; calyx 3 mm. long, minutely glandular-pubescent, subtruncate, teeth minute; corolla-tube only slightly longer than the calyx, puberulent without; corolla-limb 3.5 mm. broad; segments more or less rounded, the middle posterior one emarginate; nutlets oblong, 2–2.5 mm. long.

Distribution: New Jersey and Virginia to North Carolina (acc. to Small).

Specimens examined:

Virginia: Marion, Smyth Co., 1 July 1892, *Small* (P); Marion, Smyth Co., 6 July 1892, *Small* (G, MBG).

North Carolina: near Globe, Caldwell Co., 3 July 1891, *Small & Heller* (F); near falls of Yadkin, Stanley Co., 18 Aug. 1891, *Small & Heller* (F).

The material at hand is too scanty and too immature to give many clues to the probable relationship of this species. It would seem as nearly related to *V. officinalis* as to either *V. hastata* or *V. urticifolia.* It is characterized by pinnatifid or tripartite leaves, minutely glandular-pubescent inflorescence, and fruit about twice as long as thick.

10. **V. Ehrenbergiana** Schauer in DC. Prodr. **11**: 548. 1847.

Stem erect, branched, hirsute; leaves trifid with lateral lobes small, somewhat ovate with cuneate base narrowed into a margined petiole, attenuate at apex, 4–8(–10) cm. long, coarsely serrate-dentate, strigillose above, hirtellous below, also somewhat paler and prominently veined; spikes paniculately disposed, very slender, remotely flowered; bracts ovate, about one-half as long as the calyx or shorter, subulate, ciliate; fruiting calyx

about 1.5 mm. long, strigillose, lobes very short, obtuse, mucronate; corolla inconspicuous, limb about 1 mm. broad; nutlets trigonous with convex back, 1 mm. long; commissural faces meeting sharply at right angles, almost smooth.

Distribution: Mexico.
Specimens examined:
MEXICO:
COAHUILA: Saltillo, July 1880, *Palmer 2037* (G).
NUEVO LEON: moist places near Monterey, July 1888, *Pringle 1948* (ANSP, F, G, MBG, NY, US).
SAN LUIS POTOSI: Tancanhuitz, Feb. 1888, *Seler 722* (G, US); Rio Verde, 17 Nov. 1910, *Orcutt 5423* (MBG); Bagre, Minas de San Rafael, July 1911, *Purpus 5451* (F, G, MBG, NY, US).
HIDALGO: Cazadero, April 1841, *Liebmann 11335* (US).
VERA CRUZ: Wartenberg, near Tantoyuca, 1858, *Ervendberg 153* (ANSP, G).
PUEBLA: Pahuatlan, 12 July 1913, *Salazar* (US).
MEXICO: near Los Reyes, *Ehrenberg 713* (Bot. Mus. Berl.-Dahl. TYPE, MBG phot.).

In general habit this species somewhat approaches *V. carolina.* It differs, however, in its tripartite leaves, smaller flowers, and fruits. The collection from Saltillo is much more densely hirsute on all parts, but apparently is conspecific.

11. **V. carolina** L. Syst. ed. 10, 852. 1759; Sp. Pl. ed. 2, 29. 1762.

V. caroliniana Willd. Sp. Pl. **1**: 119. 1798.

V. polystachya HBK. Nov. Gen. et Sp. **2**: 274. 1818.

V. biserrata HBK. *l. c.* 275.

V. veronicaefolia HBK. *l. c.*

V. hirsuta Mart. & Gal. in Bull. Acad. Brux. **11**^{2}: 321. 1844.

V. mollis Mart. & Gal. *l. c.* 323.

V. paucifolia Mart. & Gal. *l. c.* 324, as *V. pauciflora* M. & G. in Walp. Rep. **6**: 687. 1846–47.

V. caroliniana forma or var. *polystachya* (Kunth) Loes. in Fedde, Rep. Sp. Nov. Veg. **9**: 362. 1911.

Stems erect or ascending, usually solitary, branched, hirsute-hispid; leaves lanceolate-oblong or somewhat elliptical, 3–8(–12) cm. long, obtusish or acute, subsessile or narrowed into a short petiole, coarsely crenate-serrate, strigose and somewhat pustulate above, hirsute-strigose especially along the midrib and veins beneath; spikes paniculately disposed, slender, open in fruit; bracts ovate, varying in length, usually about one-half as long as

the calyx or shorter, acuminate-subulate, somewhat spreading, ciliate; fruiting calyx approximately 2 mm. long, with the obtuse mucronate lobes connivent, hispidulous; corolla-tube scarcely exserted; corolla-limb inconspicuous, about 2 mm. broad; mature schizocarp inclosed by calyx; nutlets trigonous with convex back, hardly 1.5 mm. long, faintly striate; commissural faces meeting at right angles, almost smooth.

Distribution: Arizona and Mexico to Salvador, Central America.

Specimens examined:

ARIZONA: Wilgus Ranch, Chiricahua Mountains, 12 Oct. 1907, *Blumer 1783* (G, MBG, NY, US); Cave Creek, Chiricahua Mountains, 2 Sept. 1929, *Harrison & Kearney 6144* (US); Santa Rita Mountains, 15 July 1881, *Pringle* (G); Fort Huachuca, July 1893, *Wilcox* (NY); Huachuca Mountains, 4 Sept. 1903, *Jones* (P, US); Ramsay Canyon, Huachuca Mountains, 30 Sept. 1929, *Jones 25006* (G, NY).

NEVADA: Carson Valley, Aug. 1872, *Lemmon 3075* (G).

MEXICO: without data, *Graham* (G); collection of 1844, *Galeotti 795A* (G, US).

LOWER CALIFORNIA: Sierra de San Francisquito, 1 Oct. 1899, *Brandegee* (NY).

SONORA: Santa Cruz, 22 Oct. 1893, *Mearns 2627* (US); Cochuto, 1 Oct. 1890, *Hartman 94* (G, NY, US); La Cruz de los Canadas, 3 Nov. 1890, *Lloyd 448* (G).

SINALOA: near Colomas, foothills of Sierra Madre, 15 July 1897, *Rose 1677* (US); Santa Lucia, 1919, *Dehesa 1551* (US).

CHIHUAHUA: Norogachi, Aug.–Nov. 1885, *Palmer 364* (ANSP, G, US); San Diego Canyon, Sierra Madre Mountains, 16 Sept. 1903, *Jones* (P); Guayanopa Canyon, Sierra Madre Mountains, 23 Sept. 1903, *Jones* (P).

DURANGO: rich bottom-lands, vicinity of Durango, Apr.–Nov. 1896, *Palmer 339* (F, G, MBG, NY, US).

NAYARIT: west of Tepic, 31 May 1849, *Gregg 1001* (MBG); Tepic, 5 Jan.–6 Feb. 1892, *Palmer 2057* (US).

JALISCO: Cuidad Guzman, 14 Oct. 1921, *Kempton & Collins* (US).

GUANAJUATO: Guanajuato, 1880, *Duges* (G).

HIDALGO: Real del Monte, 15 Sept. 1910, *Clokey 1865* (MBG); near Moran, *Humboldt & Bonpland* (Par. TYPE of *V. veronicaefolia*, MBG phot.).

VERA CRUZ: Sierra Templada in general, June–Oct. 1840, *Galeotti 735* (K), TYPE collection of *V. hirsuta;* Orizaba, 1853, *Mueller* (NY); Orizaba, 1855, *Mueller 766, 887* (NY); Orizaba, 1855–7, *Botteri 180* (F, G, MBG, US); Orizaba, 1857, *Mohr* (US); Jalapa, *Schiede 88* (NY); Jalapa, Jan. 1894, *C. L. Smith 1737* (G).

PUEBLA: region of Atoyac, near Puebla, 15 July 1909, *Nicholas* (US); Tezuitlan, 9 June 1910, *Orcutt 4045* (F).

MEXICO: near city of Mexico, *Humboldt & Bonpland* (Par. TYPE of *V. biserrata*, MBG phot.); valley of Mexico to Tizapan, 19 Aug. 1865–66, *Bourgeau 119* (G, US); Chalco region, 4 Oct. 1921, *Kempton & Collins* (US); near Tlalpam, 1905, *Rose, Painter & Rose 8496* (US); Tlalpam, 9 Aug. 1910, *Orcutt 3488* (F, US); Eslava, 15 June 1901, *Pringle 9312* (F, G, MBG, NY, US); near Toluca, 18 Sept. 1889, *Pringle 2813* (F, G).

MORELOS: fields, La Cascada, 29 May 1901, *Pringle 9529* in part (G, MBG, NY); Toro, 5 Aug. 1924, *Fisher* (F, MBG); Tepoztlan, autumn 1926, *R. Redfield 4* (US).

MICHOACAN: Morelia, Coronilla, 8 Aug. 1909, *Arsène 3000* (US); Quinceo, near

Morelia, 11 Nov. 1909, *Arsène* (US); on slope of volcanic mountain, Xorullo, *Humboldt & Bonpland* (Par. TYPE of *V. polystachya*, MBG phot.).

Colima: Colima, 9 Jan.–6 Feb. 1891, *Palmer 1156* (G, NY, US).

Oaxaca: mountains near Oaxaca, June–Oct. 1840, *Galeotti 737* (K), TYPE collection of *V. mollis;* Sierra de San Felipe, 12 Sept. 1894, *Pringle 4892* (ANSP, G, MBG, NY, US); Sierra de San Felipe, 2 Oct. 1894, *C. L. Smith 224* (MBG, NY, US); vicinity of La Parada, 19 Aug. 1894, *Nelson 1021* (US); Cuyamecalco, 5 Sept. 1895, *L. C. Smith 634* (G).

Central America:

Guatemala: uncultivated places, Oct. 1865, *Bernoulli 127* (NY); without locality, Sept. 1927, *Morales 786* (US); without locality, 1892, *Heyde 120, 530, 477* (US); San Siguan, Dept. Quiche, April 1892, *Heyde & Lux 3018* (ANSP, MBG, US); Coban, Dept. Alta Verapaz, Nov. 1902, *von Tuerckheim 8442* (F, G, NY, US); Coban, Dec. 1906, *von Tuerckheim II 651* (F, MBG); Tactic, Dept. Alta Verapaz, May 1886, *von Tuerckheim 913* (G, US); vicinity of Los Amates, Dept. Izabal, 24 May 1922, *Standley 24443* (MBG, US); Proderos, Dept. Guatemala, July 1921, *Tonduz 628* (US); Chilloui, Dept. Guatemala, 20 June 1921, *Rojos 44* (US); Volcan Pacaya, Dept. Amatitlan, July 1892, *Shannon 3638* (US); San Vincente, Pacaya, Dept. Amatitlan, 5 May 1921, *Tonduz 488* (US); San Lucas, Dept. Solola, 16 Feb. 1906, *Kellerman 5825* (US); San Pedro, 1913, *Tejada 72* (US); Tejutla, 1913, *Tejada 57* (US); Santa Rosa, Dept. Santa Rosa, May 1892, *Heyde & Lux 3019* (G in part, NY, US); vicinity of Siguatepeque, Dept. Comayagua, 14–27 Feb. 1928, *Standley 55944* (F, US).

Salvador: vicinity of Apastepeque, Dept. San Vincente, 4 March 1922, *Standley 21331* (G, MBG, US); vicinity of San Salvador, *Renson 175* (NY, US); Plazuela de Aculhaca, San Salvador, Dec. 1906, *Velasco 8999* (US); Amatepeque Hill, near San Salvador, 2 Feb. 1907, *Pittier 1909* (US); San Salvador, 1922, *Calderon 794* (G, US); vicinity of San Salvador, 30 March–24 April 1922, *Standley 22414* (G, NY, US); vicinity of Santa Tecla, Dept. La Libertad, 10 April 1922, *Standley 23083* (G, US); Finca San Nicolas, 1923, *Choussy 36* (US).

This species is probably most nearly related to *V. urticifolia* and *V. scabra,* but is easily set apart from them by its subsessile or very short-petiolate leaves; moreover, their areas of distribution are practically distinct. The collections cited appear to be conspecific, notwithstanding the fact that they vary greatly in size, serration of leaves, and length of floral bracts. The specimens from the northern part of the range are slightly coarser, with leaves more remotely crenate-serrate, yet they match very closely *Pringle 4892*, from the Sierra de San Felipe, Oaxaca. In the latter, however, the leaves are more densely pubescent on the under surface. The specimens from Guatemala and Salvador have somewhat crowded spikes and are, as a whole, smaller in every way and more densely hispidulous. However, since most of the collections were made from December to February, it seems as if this more compact habit might be a seasonal rather than a geographic variation.

A specimen labelled "Inter Tallahassee et St. Marks, Florida, legit Rugel, April–June 1843" appears in the herbarium of the Missouri Botanical Garden. As this is the only representative of *V. carolina* seen from Florida, and as it is so far from the natural range of the species, it would appear to be an error in labelling. Another collection worthy of mention is *Nelson 752*. It is almost glabrous, and the lobes of the corolla are emarginate, a rather unusual feature in this series. The lack of pubescence suggests *V. longifolia*, but unfortunately none of the available material of the species is in sufficiently good condition to reveal the character of the corolla. Although the general habit of the collection is that of *V. carolina*, it is rather doubtfully conspecific.

12. V. recta HBK. Nov. Gen. et Sp. **2**: 277. 1818.

V. caroliniana forma or var. *recta* (Kunth) Loes. in Fedde, Rep. Sp. Nov. Veg. **9**: 362. 1911.

Stem erect, branched, hispidulous, reddish; leaves lanceolate-oblong to ovate with cuneate base narrowed into a short margined petiole, 4–8 cm. long, acute, serrate-dentate, reticulately veined, strigillose on both surfaces, minutely pustulate above; spikes numerous, congested at the apices of stems and branches, short-cylindrical, usually dense but not strict; bracts a little shorter than the calyx, ovate-lanceolate, acuminate, hispidulous; fruiting calyx about 2 mm. long, hispidulous, lobes short, obtuse, mucronate, commonly connivent; corolla-tube scarcely exserted; corolla-limb inconspicuous; nutlets trigonous with convex back, 1.5–2 mm. long, faintly striate; commissural faces meeting at right angles, practically smooth.

Distribution: Mexico.

Specimens examined:

Mexico:

Hidalgo: Real del Monte, 12 July 1913, *Salazar* (US); between Pachuca and Cerro Ventoso, *Humboldt & Bonpland 4066* (par. type, MBG phot.).

Puebla: Huitzuilzilapam, 9 June 1910, *Orcutt 3950* (F).

Mexico: Cima Station, 30 Aug. 1905, *Pringle 13597* (G, US); Toluca, *Berlandier 1222* (US).

Morelos: Tres Marias, 4 July 1901, *Rose & Hay 5310* (US); Toro, 5 Aug. 1924, *Fisher 320* (MBG, US).

Oaxaca: vicinity of Cerro San Felipe, 1894, *Nelson 1105* (US); Sierra de San Felipe, 9 Aug. 1894, *Pringle 4769* (ANSP, F, G, MBG, NY, US).

Verbena recta, generally determined in the material at hand as "aff. *V. polystachya* HBK.," is easily distinguished from this closely related species by the short hispidulous pubescence, the commonly broader leaves, and the compact cylindrical congested spikes. The floral characters of both are similar, although generally the fruiting calyx of *V. carolina* is more acutely ovoid and the subtending bract is much sharper at the apex.

13. **V. longifolia** Mart. & Gal. Bull. Acad. Brux. 11²: 323. 1844.

Stems erect, tall, glabrous, obtusely 4-angled; leaves lanceolate to elongate-elliptic, 10–12 cm. long, the upper somewhat smaller, decussate, short-petiolate, acutely serrate from below the middle to the apex, appressed-pubescent or very short-strigillose on both surfaces, venation prominent beneath; spikes paniculately disposed, elongate, slender, open in fruit, glabrous; bracts ovate, about one-half as long as the calyx, acute-acuminate, minutely ciliate; calyx 2 mm. long, with the obtuse lobes connivent over the schizocarp, practically glabrous; corolla-tube scarcely protruding beyond the calyx; corolla-limb inconspicuous; nutlets trigonous, hardly 1.5 mm. long, smooth or faintly striate; commissural faces smooth.

Distribution: southern Mexico.

Specimens examined:

MEXICO:

VERA CRUZ: Colipa, March 1841, *Liebmann 11318* (US); near Chila, April 1888, *Seler 724* (G, US).

PUEBLA: in vicinity of San Luis Tultitlanapa, July 1908, *Purpus 3406* (F, G, MBG, NY, US).

MORELOS: San Anton, near Cuernavaca, 14 Oct. 1904, *Seler 4194* (G, US); Cuernavaca, 28 Oct. 1905, *Seler 4347* (G, US).

OAXACA: Tehuantepec, 19 April 1910, *Orcutt 3321* (F, MBG, US).

A rather singular species combining the foliar characters of *V. litoralis* with the inflorescence characters of *V. carolina*.

14. **V. scabra** Vahl, Eclog. Am. 2: 2. 1798, not *V. scabra* Marnock, Floricult. Mag. 5: 87, *pl. 54, fig. 2*. 1840–41.

Stem 1 m. more or less tall, erect, solitary, simple or branched, hispidulous; leaves ovate to elongate-ovate, 3–10(–13) cm. long, 2.5–5 cm. broad, petiolate, serrate-dentate, acute or obtusish,

scabrous and commonly strigillose above, less scabrous and somewhat paler beneath, also hispidulous along the veins; spikes paniculately disposed, slender, pedunculate, copiously and closely flowered; bracts ovate-acuminate, about half as long as the calyx, hispidulous; fruiting calyx 2.5–3 mm. long, hispidulous, ovoid, with the somewhat unequal lobes acutely connivent, diverging from the rhachis of the spike 45° or more; corolla-tube scarcely, if at all, longer than the calyx; corolla-limb about 2 mm. wide, lobes obtuse; anthers glandless; stigmatic surface midway between two almost equal obtusish sterile lobes; nutlets trigonous, 1–1.3 mm. long, faintly striate, reticulate above; commissural faces extending to the top of the schizocarp, meeting sharply at right angles, muriculate.

Distribution: North Carolina, Florida west to California, south into northwestern Mexico; West Indies.

Specimens examined:

North Carolina: moist rich soil, open swamp land, Wilmington, 25 July 1922, *Randolph 1012* (G).

Florida: without locality, 1842–49, *Rugel 156* (F, MBG); common in everglades, 27 Aug. 1925, *O'Neill* (MBG); vicinity of Mayport and Jacksonville, 1870–76, *Keeler* (NY); near Jacksonville, 25 June–13 July 1894, *Curtiss 5111* (MBG, NY); Lake City, 21 July 1893, *Quaintance* (MBG); vicinity of Eustis, Lake Co., 1–15 July 1894, *Nash 1248* (G, MBG, NY); low ground, Orange Co., 22 July 1902, *Fredholm 5416* (G, MBG, P, US); open low ground, near Lake Okeechobee, 20 May 1925, *E. J. Palmer 27462* (MBG); east shore of Lake Okeechobee, 11–25 Nov. 1913, *Small & Small 4337* (NY); east shore of Observation Island, 11–25 Nov. 1913, *Small & Small 4403* (NY); hammocks along Taylor Creek, 11–25 Nov. 1913, *Small & Small 4341* (NY); Fort Lauderdale, 19–25 Nov. 1903, *Small & Carter 1072* (F, NY); moist sandy soil, Hollywood, Broward Co., 10 Feb. 1930, *Moldenke 591*, *599a* (MBG, NY); everglades west of Miami, 3 Nov.–7 Dec. 1912, *Small 4020* (NY); hammocks near Miami River, 26 Nov.–20 Dec. 1913, *Small & Small 4580* (NY); Biscayne Bay-Indian River, *Palmer 397* (G, MBG); Myers, Lee Co., July–Aug. 1900, *Hitchcock 269* (MBG); sandy ditch, south of Estero, Lee Co., 14 April 1930, *Moldenke 972* (MBG, NY); Sanibel Island, 18 May 1901, *Tracy* (NY); Manatee, 8 May 1900, *Tracy 6652* (G, MBG, NY); Hernando Co., June–July 1898, *Hitchcock* (MBG); near Tallahassee, *Berg* (NY); shore of Dog Island Sound, near Lanark, 26 July 1920, *Harper 242* (NY, US); streets of Apa[lachicola], *Chapman* (MBG).

Mississippi: Scranton, Jackson Co., 5–6 Aug. 1896, *Pollard 1191* (G, MBG, NY); Ocean Springs, 13 Aug. 1895, *Skehan* (MBG).

Louisiana: South Pass, 20 Aug. 1900, *Tracy & Lloyd 22* (G, MBG); New Orleans, *Riddell* (G); New Orleans, *Drummond* (NY); New Orleans, 21 Oct. 1885, *Joor* (MBG).

Texas: without locality, July 1851, *Lindheimer 618* (MBG); Beaumont, Jefferson Co., 11 Sept. 1916, *E. J. Palmer 10692* (MBG); Beaumont, Sept. 1904, *Kirn 2139* (P); Houston, July 1842, *Lindheimer* (MBG); Comanche Springs, New Braunfels,

etc., Aug. 1851, *Lindheimer 1077* (G, MBG, NY); Leon River, Oct. 1850, *Bigelow* (G); San Marcos and vicinity, 1898, *Stanfield* (NY); New Braunfels, 1847, *Lindheimer* (MBG).

ARIZONA: north of Rice, Apache Reservation, 4 Oct. 1927, *Harrison 4897* (US); Santa Cruz River, Tucson, 11 May 1881, *Pringle* (G); banks of Santa Cruz River, near Tucson, 18 July 1884, *Pringle* (ANSP, F, G, NY, P, US).

CALIFORNIA: without locality, *Wallace* (G); Cienega, on Santa Monica R. R., *Lyon 6* (G); Los Angeles, 1892, *Davidson* (G); near Pasadena, 17 Dec. 1892, *McClatchie* (NY); San Bernardino, Oct. 1891, *Parish* (MBG), *5338* (NY); San Bernardino Valley, *Parish & Parish 1043* (F, MBG); San Bernardino Valley, 25 July 1909, *Parish 7149* (P); 3 km. south of San Bernardino, 2 Sept. 1924, *Johnston* (P); Upland, July 1917, *Johnston* (P); 8 km. southeast of Chino, *Munz & Johnston 11289* (P); Cocomozo Mountains, Aug. 1881, *Parish & Parish 11143* (G).

MEXICO:

LOWER CALIFORNIA: San Tomas, 15 July 1885, *Orcutt 1302* (MBG).

COAHUILA: Soledad, a section of low mountains with few oaks, 40 km. southwest from Monoclova, 9–19 Sept. 1880, *Palmer 1040* (ANSP, US); San Lorenzo de Laguna, 120 km. southwest of Parras, May 1880, *Palmer 1040* (G).

WEST INDIES:

CUBA: without locality, 1865, *Wright 3659* (G); Santa Rosalia, 2 Aug. 1895, *Combs 389* (G, MBG, NY); valley of San Juan, vicinity of Matanzas, 14 March 1903, *Britton, Britton & Shafer 292* (NY); Havana, 15 Oct. 1908, *Leon 685* (NY); Havana, 21 April 1919, *Leon & Edmunds 8719* (NY); Rio Arimao, 22 March 1910, *Britton & Wilson 5771* (NY); Isle of Pines, 8 March 1916, *Britton, Wilson & Leon 15256* (NY); Pinar del Rio, 7 April 1924, *Krig 3187* (NY).

JAMAICA: Port Antonio, Dec. 1890, *Hitchcock* (MBG); Port Antonio, Aug. 1910, *Lang 102* (ANSP); marsh near Black River, 12 Sept. 1907, *Harris 9937* (NY); roadside, Hopeton, 13–22 Sept. 1907, *Britton 1527* (NY); Och Rios and vicinity, 4 April 1908, *Britton & Hollick 2704* (NY); banks of Cabaritta River, Meylersfield, 16 Dec. 1914, *Harris 11808* (G, MBG, NY).

HAITI: Prov. Barahona, Aug. 1910, *Fuertes 391* (NY); Prov. La Vega, July 1912, *Fuertes 1758* (NY); Miragoane and vicinity, July 1927, *Eyerdam 201*, *432* (G).

PORTO RICO: without locality, *Read* (ANSP); Bayamon, 22 March 1885, *Sintenis 1074* (MBG, NY); Aybonito, 3 Nov. 1885, *Sintenis 2010* (ANSP, P); Vega Baja, 5 Nov. 1913, *Stevens & Hess 4260* (NY); El Teudal, Coamo River, 13 Feb. 1922, *Britton, Britton & Brown 6019* (NY); border of Mary Lake, near Luquillo, 3 April 1922, *Britton, Britton & Brown 7037* (NY).

BERMUDA: Smith's Parish, 12 July 1905, *Moore 2947* (G, NY); Hamilton Parish, 9 July 1905, *Moore 2874* (G, NY); cultivated land north of Hamilton Parish, 31 Aug.–20 Sept. 1905, *Brown & Britton 373* (ANSP, G, NY); Washington Sound, Sept. 1913, *Brown & Britton 1631* (ANSP, NY); roadside, 3 Aug. 1913, *Collins 268* (G, NY).

Verbena scabra, often confused with *V. urticifolia*, is easily separable by the very scabrous upper surface of the leaf and the rather conspicuous divergence of the fruit from the rhachis of the spike. A quite distinctive feature is the position of the stigmatic surface apparently between two almost equal sterile

style-lobes. This condition is somewhat approached in *V. carolina*, but in the other species examined the second sterile lobe has never been so definitely developed.

15. **V. urticifolia** L. Sp. Pl. 20. 1753.

V. diffusa Poir. in Lam. Encyc. **8**: 550. 1808.

V. diffusa Desf. ex Spreng. in L. Syst. **2**: 748. 1825.

V. urticifolia var. *simplex* Farwell, Papers Mich. Acad. Sci. **3**: 103. 1924.

Erect herb 5–15 dm. tall; stem solitary, simple or more often branching from near the base, hirtellous to almost glabrous; leaves 8–20 cm. long, petiolate, blades broadly lanceolate to oblong-ovate, with rounded base decurrent on the petiole, short-acuminate or acute, coarsely and somewhat doubly crenate-serrate, hirtellous or glabrate on both surfaces, often minutely pustulate above; spikes paniculately disposed, slender, pedunculate, more or less sparsely flowered; bracts ovate-acuminate, very short, ciliate; calyx 2 mm. long, pubescent particularly along the nerves, lobes obtuse, not connivent, teeth short, subulate, subequal; corolla-tube scarcely exserted; corolla-limb about 2 mm. wide, lobes obtuse; mature schizocarp exposed at the distal end; nutlets trigonous with a convex back, about 2 mm. long, faintly striate; commissural faces meeting at right angles, almost smooth.

Distribution: Quebec and Ontario, Maine to Nebraska and southward.

Specimens examined:

Quebec: vicinity of Longueuil, Aug. 1916, *Victorin 3124* (MBG); Cape Tourmente, 40 km. below Quebec, 12 Aug. 1922, *Victorin 15750* (G).

Ontario: Casselman, 24 Aug. 1891, *Scott* (G); Niagara Falls, 1830, ? *Torrey 154* (NY).

Maine: North Berwick, 25 Sept. 1897, *Fernald & Parlin 928* (G).

New Hampshire: Walpole, 28 July 1901, *Williams* (G); Ashuelot, 1 Aug. 1898, *Robinson 559* (G).

Vermont: East Middlebury, 14 July 1908, *Williams* (G); Rutland, 31 Aug. 1899, *Eggleston 1531* (G); Manchester, 21 July 1898, *Day 147* (G); Brattleboro, 2 Aug. 1898, *Robinson 134* (G).

Massachusetts: Lowell, 28 July 1927, *Beattie* (P); slopes above Connecticut River, Holyoke, 7 Sept. 1926, *Seymour 601* (MBG, NY); Waverley, 10 Aug. 1878, *Lane* (G); Belmont, 27 Sept. 1891, *Deane* (G); Milton, 3 Aug. 1887, *Kennedy* (G); South Framingham, 25 July 1890, *Sturtevant* (MBG); Dedham, 22 Aug. 1897, *Williams* (G); Adams, 24 Aug. 1901, *Day 79* (G); Manchester, 18 Aug. 1895, *Williams* (G); Monson, Aug. 1897, *Morris* (MBG); Nonquit, 1888, *Sturtevant* (G).

Rhode Island: dry roadside banks and thickets northeast of Great Salt Pond, Block Island, 20 Aug. 1913, *Fernald, Hunnewell & Long 10262* (G); Providence, July 1844, *Thurber* (G); Providence, 20 July 1892, *J. F. Collins* (G).

Connecticut: in damp woods, Wethersfield, *Wright* (G); Hartford meadow, 3 Aug. 1882, *Wright* (G); New Haven, 1858, *Eaton* (MBG).

New York: open pasture, Canton, 18 July 1914, *Phelps 800* (G); Bolton Landing, Lake George, 11 Aug. 1906, *Seler 4560* (G); Vaughns, north of Hudson Falls, 8 Aug. 1912, *Burnham* (G); near station, Ithaca, 4 Aug. 1915, *Eames & McDaniels 4870* (G); Fall Creek, Ithaca, 12 July 1916, *Munz 616* (P); Six Mile Creek, Ithaca, 8 July 1878, *Trelease* (MBG); Fleischmanns, Delaware Co., 30 July 1892, *von Schrenk* (MBG); Port Chester, 3 Sept. 1886, *Stabler* (G).

New Jersey: Green Pond, Morris Co., 21 Sept. 1886, *Britton* (NY); Denmark Pond, 7 Aug. 1910, *Mackenzie 4746* (G, MBG); Watchung, Somerset Co., 7 July 1930, *Moldenke 1330* (MBG, NY); South Amboy, July 1892, *Halsted 175* (G, NY).

Pennsylvania: about Tunkhannock, 18 July 1929, *Osterhout* (P); Meadville, Aug. 1893, *Curtis* (P); Harrisburg, 20 July 1888, *Small* (G); Lancaster, 29 Aug. 1900, *Heller* (G); woodlands, Angora, 9 July 1899, *MacElwee 882* (MBG); near Philadelphia, 29 July 1871, *Redfield* (MBG); near Philadelphia, 1890, *Greenman 1376* (G, MBG).

Delaware: marsh along Delaware River, south of Newcastle, 2 Aug. 1923, *Tidestrom 11572* (G).

Maryland: College Park, *Symons* (MBG); Chesapeake City, 11 July 1923, *Tidestrom 11413* (G).

District of Columbia: gravelly and cindery artificial soil, northeast Washington, 24 July 1893, *Boettcher 226* (G, MBG); Anacostia, 19 July 1893, *Boettcher 176* (G, MBG); Brookland, 19 July 1912, *Holm* (MBG); near Long Bridge, 11 July 1891, *Blanchard* (MBG).

Virginia: Chisels Run, west of Williamsburg, 22 June 1921, *Grimes 3794* (NY); Reed Creek, Wythe Co., 23 July 1892, *Small* (MBG, NY); Marion, Smythe Co., 20 July 1892, *Small* (MBG).

North Carolina: Cranberry Station, 13 Sept. 1885, *Britton* (NY).

South Carolina: near Anderson, 8 July 1919, *Davis 9117*, *8458* (MBG); Santee Canal, *Ravenel* (G); Charleston, 19 Aug. 1859, *Gibbes* (NY).

Florida: Apalachicola, *Chapman* (MBG); near Tallahassee, May 1843, *Rugel* (MBG).

Alabama: Tensaw, 22 Aug. 1904, *Tracy 8037* (G, MBG, NY).

Mississippi: Woodville, 7 Sept. 1887, *Joor* (MBG); Taylorville, 2 Aug. 1903, *Tracy* (NY).

Louisiana: without data, *Hale* (G); Natchitoches, 14 June 1915, *E. J. Palmer 8000* (MBG); waste ground, Alexandria, 5 June 1899, *Ball 556* (G, MBG); Lockport, 23 Oct. 1919, *Guidroz 3* (G).

Ohio: Shaker Pond, near Cleveland, 8 July 1896, *Greenman 1380* (MBG); Oberlin, June 1895, *Hicks* (MBG); Oxford, 6 June 1910, *Overholts* (MBG); Cincinnati, 18 Oct. 1930, *Stephenson* (MBG).

West Virginia: Tygart River valley, above Huttonsville, 23 Sept. 1904, *Greenman 244* (G); banks of Blackwater River, Hendricks, 10 Sept. 1904, *Greenman 245* (G); low ground west of Salt Pond, 28 June 1922, *Randolph 474* (G).

Indiana: East Chicago, 10 Aug. 1910, *Lansing 2806* (G).

Kentucky: Stamping Ground, 1 July 1930, *Singer 308* (MBG); Rockdale, July

1928, *Runyon 1260* (US); Nicholasville, 18 July 1923, *McFarland 92* (MBG); Bowling Green, Aug. 1896, *Price* (MBG); Calvert City, 16–19 June 1909, *Eggleston 4841* (NY).

TENNESSEE: borders of woods, Knoxville, July 1898, *Ruth 833* (MBG), *788* (NY).

WISCONSIN: St. Croix Falls, July 1899, *Baker* (P); Green Bay, 7 July 1878, *Schuette* (NY).

ILLINOIS: Bowmanville, Cook Co., 7 July 1896, *Chase* (MBG); Chicago, 19 Aug. 1907, *Greenman 1877* (MBG); Starved Rock, June–Sept. 1921, *Thone 50* (MBG); Urbana, 6 July 1899, *Gleason 718* (G); Olney, 17 July 1927, *Ridgway 2831* (MBG); near Alton, 24 July 1927, *Bucholz* (MBG); Freeburg, Aug. 1917, *Hertel* (MBG).

MINNESOTA: open grounds, Collegeville, Stearns Co., 29 July 1912, *Chandonnet* (MBG); near Minneapolis, July 1891, *Aiton 8467* (P); meadow, Northfield, 1912, *Goldsmith 119* (NY); Houston Co., July 1912, *Freiberg* (MBG).

IOWA: Black Hawk Co., 22 July 1929, *Burk 591* (MBG); Ames, *Hitchcock* (MBG); Ames, Sept. 1873, *Bessey* (G); Ames, Sept. 1909, *Campbell 67* (G, MBG); Bentonsport, July 1920, *Graves 1691* (MBG); Decatur Co., 13 July 1903, *Anderson* (MBG).

MISSOURI: Hannibal, Marion Co., *Davis 73, 1274a, 3453, 3591, 4450, 4565* (MBG); Ilasco, Ralls Co., 13 Aug. 1915, *Davis 3852* (MBG); Aberdeen, 11 Sept. 1911, *Davis 950* (MBG, NY); St. Louis, Aug. 1838, *Riehl 135* (MBG, NY); St. Louis, 11 Aug. 1894, *Glatfelter* (MBG); St. Louis, Sept. 1899, *Baker* (P); Creve Coeur Lake, 24 Aug. 1930, *Kellogg 15277* (MBG); Fern Glen, St. Louis Co., 14 July 1906, *Johnson* (MBG); Allenton, *Letterman* (MBG); Allenton, 27 July 1884, *Kellogg* (MBG); Kimmswick, 15 July 1885, *F. Wislizenus 282* (MBG); Victoria, 6 July 1890, *Hitchcock* (MBG); Shepard Mountain, near Arcadia, 22 July 1915, *Greenman 3766* (MBG); Poplar Bluff, 14 Aug. 1892, *Dewart 15* (MBG); Jefferson City, July 1866, *Knause* (MBG); Brumley to Bagnell, 21 Sept. 1897, *Trelease 719* (MBG); Springfield, 31 July 1892, *Dewart 18* (MBG); Willard, 9 July 1919, *Blankinship* (P); Swan, 24 Sept. 1899, *Bush 452* (MBG); Jackson Co., 7 Aug. 1893, *Bush* (MBG); bottoms, Cass Co., 24 July 1864, *Broadhead* (MBG); Webb City, 4 July 1902, *E. J. Palmer 198* (MBG); gravel bars, Butler Creek, Noel, 9 Sept. 1913, *E. J. Palmer 4229* (MBG).

ARKANSAS: waste places, near Corning, 21 Aug. 1896, *Eggert* (MBG); near McNab, 5 Oct. 1923, *Greenman 4412* (MBG); Fulton, 18 Sept. 1900, *Bush 884* (MBG).

SOUTH DAKOTA: Brookings Co., 1903, *Johnson* (MBG); Mitchell, July 1903, *Hoffstetter* (MBG); sand hills near La Creek P. O., Bennett Co., 14 Aug. 1911, *Visher 2263* (NY); Vermilion, 11 Sept. 1911, *Visher* (MBG).

NEBRASKA: Dickson's Bluffs, on Missouri River, 12 July 1853–4, *Hayden* (MBG); near Plummer Ford, Dismal River, 8 Aug. 1893, *Rydberg 1716* (NY); Lincoln, Aug. 1899, *Hedgcock* (MBG); Franklin, 1893, *Laybourne* (MBG).

KANSAS: Riley Co., 16 Aug. 1892, *Waugh* (MBG); low woods, Riley Co., 12 July 1895, *Norton 389* (G, MBG, NY); Manhattan, Sept. 1893, *Norton* (MBG); vicinity of Arkansas City, south of Arkansas River, 2 July 1929, *Rydberg & Imler 482* (NY).

OKLAHOMA: near Alva, 11 July 1913, *Stevens 1673* (G, MBG, NY); near Tonkawa, 4 Aug. 1913, *Stevens 1821* (G); 16 km. south of Stillwater, 14 July 1927, *Stratton 158* (MBG); near Cleo, 19 July 1913, *Stevens 1742* (G); vicinity of Fort Sill, 3 July 1916, *Clemens 11749* (MBG); Davis, 10 July 1916, *Emig 716* (MBG); near Grant, 4 June 1916, *Houghton 4015* (G); "Arkansas," 23 July 1894, *Bush 432* (MBG).

TEXAS: Tarrant Co., 10 Aug. 1926, *Killiam 6933* (US); Dallas, Aug. 1876, *Reverchon* (G), *734* (MBG); Houston, May 1842, *Lindheimer 195* (MBG); Columbia, 13 Oct. 1900, *Bush 1482* (MBG).

Verbena urticifolia is readily distinguished by petiolate and

rarely scabrous leaves, remotely flowered slender spikes, and unconnivent fruiting calyces. On account of its close resemblance to *V. scabra* the two were confused, and *V. urticifolia* formerly was believed to be a native of tropical America. It would now appear to be indigenous in the Middle Eastern States, establishing itself as a weed in various places.

16. **V. hastata** L. Sp. Pl. 20. 1753.

V. pinnatifida Lam. Tab. Encyc. **1**: 57. 1791, as *V. hastata* γ Poir in Lam. Encyc. **8**: 546. 1808.

V. paniculata Lam. Tab. Encyc. **1**: 57. 1791.

V. paniculata var. *pinnatifida* Schauer in DC. Prodr. **11**: 546. 1847.

V. hastata var. *pinnatifida* Gray, Syn. Fl. N. Am. **2**[1]: 336. 1878; Britton, Mem. Torr. Bot. Club **5**: 276. 1894.

V. hastata var. *paniculata* Farwell, Ann. Rept. Comm. Parks and Boul. Detroit **11**: 82. 1900.

V. hastata f. *rosea* Cheney, Rhodora **4**: 245. 1902.

V. hastata var. *paniculata* f. *rosea* Farwell, Papers Mich. Acad. Sci. **2**: 37. 1923.

Stems 4–15 dm. tall, branched above, rough-pubescent with short antrorse hairs; leaves lanceolate, oblong-lanceolate or occasionally ovate-lanceolate, 5–15(–18) cm. long, gradually acuminate, petiolate, coarsely or incised serrate, often hastately 3-lobed at base, veins impressed above, rough-pubescent on both surfaces; spikes strict, usually numerous in a panicle, pedunculate, compact; bracts lanceolate-subulate, commonly a little shorter than the calyx; calyx 2.5–3 mm. long, pubescent, lobes acute with short subulate tips, more or less connivent; corolla-tube somewhat longer than the calyx, pubescent without; corolla-limb 3–4.5 mm. broad; nutlets about 2 mm. long, nearly smooth or very faintly striate; commissural faces muriculate or almost smooth.

Distribution: Nova Scotia to British Columbia, south throughout the United States.

Nova Scotia: bank of Five-mile River, Hants Co., 19 July 1920, *Pease & Long 22350* (G).

New Brunswick: Nepisiguit, 30 July 1873, *Fowler* (MBG); alluvium of Nashwaak River, Nashwaak, 31 July 1922, *Fernald & Pease 25247* (G).

Quebec: La Trappe, 5 Aug. 1926, *Louis-Marie 141* (G); swamp, Ascot, Sherbrooke

Co., 20 July 1923, *Knowlton* (G); sand-plains, northwest of Three Rivers, 1 Aug. 1923, *Chamberlain & Knowlton* (G).

ONTARIO: Ashdod, 24 July 1893, *Fowler* (MBG); Kingston, Sept. 1897, *Fowler* (G); Aylmer, 5 Aug. 1912, *Fisher* (MBG).

MAINE: gravelly shore of St. John River, St. Francis, 5 Aug. 1893, *Fernald* (G); Foxcroft, 18 July 1895, *Fernald 296* (G, MBG); North Berwick, 28 Aug. 1891, *Parlin* (G); Eliot, 27 Aug. 1895, *Williams* (G).

NEW HAMPSHIRE: bank of "Connt" [Connecticut] River, 1894, *Jesup* (G); Success, Coos Co., 24 Aug. 1908, *Moore 4316* (G); roadside, Walpole, 28 July 1901, *Williams* (G); roadside, East Jaffrey, 10 July 1897, *Robinson 196* (G).

VERMONT: Weybridge, 8 July 1908, *Williams* (G); fields, Brandon, 7 July 1921, *Dutton* (MBG); Mechanicsville, 6 Aug. 1906, *I. W. Anderson* (G); Manchester, 6 July 1898, *Day 149* (G); Brattleboro, 2 Aug. 1898, *Robinson 153* (G).

MASSACHUSETTS: by Merrimac River, Lowell, 8 Aug. 1927, *Beattie* (P); Melrose, 17 July 1876, *Morong* (MBG); Waverly, 10 Aug. 1878, *Lane* (G); South Framingham, 11 Aug. 1888, *Sturtevant* (MBG); Jamaica Plain, *Faxon* (G); Wigwam Pond, Dedham, 6 Oct. 1901, *Williams* (G): Nine Mile Pond, Cape Cod, 4 Sept. 1898, *Greenman 398* (G, MBG); shore of Wequawket Pond, Centreville, 6 Sept. 1896, *Williams* (G); Centreville, 20 Aug. 1902, *Cheney* (G); Nonquit, 29 Aug. 1888, *Sturtevant* (MBG); Fisher's Pond, West Tisbury, Martha's Vineyard, 4 Sept. 1917, *Seymour 1324* (G); Monson, July 1897, *Morris* (MBG); near Water Shop Pond, Springfield, 5 Aug. 1924, *Seymour 511* (MBG); South Worthington, Hampshire Co., 17 Aug. 1912, *Robinson 572* (G).

RHODE ISLAND: Providence, *Olney* (G); Providence, 16 July 1892, *Collins* (G); dense wet thickets at borders of sphagnous swamps southwest of Harbor Pond, Block Island, 19 Aug. 1913, *Fernald & Long 10263* (G).

CONNECTICUT: waste ground near river, Stafford, 9 July 1922, *Weatherby 5076* (MBG); Southington, 10 Aug. 1897, *Bissell* (MBG); Southington, 31 July 1898, *Andrews* (G); Oxford, 11 Aug. 1888, *Harger* (G); New Haven, 1858, *Eaton* (MBG).

NEW YORK: Granville, 22 Aug. 1924, *Drushel 6351* (MBG); Port Chester, 3 Sept. 1886, *Stabler* (G); Willets Neck, Long Island, 8 Aug. 1853, *Hexamer & Maier* (G); Peconic, 15 Aug. 1895, *von Schrenk* (MBG); Fleischmanns, Delaware Co., 15 July 1892, *von Schrenk* (MBG); Dryden, 3 Sept. 1915, *Dean & Thomas 4874* (G); low flats north of the city, Ithaca, 16 July 1915, *MacDaniels 4873* (G); near Bool's Brook, Ithaca, *Munz 617* (P); Keene Valley, Essex Co., 1 Aug. 1891, *von Schrenk* (MBG); Canton, 17 July 1914, *Phelps 799* (G).

NEW JERSEY: Fort Lee, 30 July 1921, *Rydberg* (P); Plainfield, 9 Aug. 1877, *Trelease* (MBG); Watchung, 11 July 1930, *Moldenke 1339* (MBG); New Market, July 1892, *Kelsey 173* (G).

PENNSYLVANIA: banks of Susquehanna River at Perdix, 4 Aug. 1926, *Heller 14222* (MBG); near Harrisburg, 13 July 1888, *Small* (G); near Philadelphia, 1889, *Greenman 1273* (G); shores of Schuylkill River, Fairmount Park, 22 July 1871, *Redfield* (MBG).

DELAWARE: along Delaware River, south of Newcastle, 2 Aug. 1923, *Tidestrom 11551* (G).

MARYLAND: below Havre de Grace Park, 2 Aug. 1902, *Shull 156* (MBG); Ellicott City, 3 Aug. 1916, *Arsène 672* (MBG).

DISTRICT OF COLUMBIA: near Long Bridge, Washington, 11 July 1891, *Blanchard* (MBG).

VIRGINIA: Langley, 10 Aug. 1901, *W. Palmer* (US); South Fork, Holston River, at St. Clair's Bottom, Smyth Co., 30 July 1892, *Small* (G, MBG).

Florida: Apalachicola, *Chapman* (MBG).

Ohio: dry places, July, *Riehl* (MBG); alluvial soil, Windham Township, Portage Co., 12 Aug. 1924, *Webb 5441* (G); Shaker Pond near Cleveland, 8 July 1896, *Greenman 1379* (G, MBG); near Cleveland, *Greenman 1377, 1382* (MBG).

West Virginia: near Tygart Junction, 24 Sept. 1914, *Moore 2569* (G, P); Marlinton, 29 July 1930, *Berkley 1304* (MBG); Woods Co., 7 Aug. 1897, *Pollock* (MBG).

Michigan: meadow, Turin, 9 July 1901, *Barlow* (G); thickets along West Maple River, west of Pellston, 7 Aug. 1917, *Gates 10708* (MBG); near Trenton, 13 Aug. 1914, *Chandler* (US); Agricultural College, 1890, *Baker* (P); South Haven, 4 Sept. 1911, *Lansing 3340* (G); Benton Harbor, 4 July 1911, *Lansing 3241* (G); New Buffalo, 20 July 1911, *Lansing* (G).

Indiana: open woods, East Chicago, 10 Aug. 1910, *Lansing 2805* (G).

Tennessee: Hollow Rock, 5 Aug. 1897, *Eggert* (MBG); along railroads, McNairy Co., July 1893, *Bain 444* (G).

Wisconsin: along Wolf River, near Keshena, 13 Sept. 1925, *E. J. Palmer 28738* (MBG); St. Croix Falls, Polk Co., July 1899, *Baker* (P); near Beef Slough, Buffalo Co., 13 Aug. 1926, *Fassett & Hotchkiss 3322* (G); near Mirror Lake, Sauk Co., July 1903, *Eggert* (MBG).

Illinois: meadow, State Street, Chicago, 4 Aug. 1907, *Greenman 1953* (MBG); old beaches, Lake Chicago, Chicago, 5 Sept. 1909, *Steele 106* (MBG); waste ground, 39th and Stoney Island, Chicago, 12 July 1913, *H. H. Smith 5654* (G); west of Kankakee, 3 Aug. 1912, *Sherff 1649* (MBG); waste land, Champaign, 31 July 1900, *Gleason 1945* (G); Beardstown, July 1842, *Geyer* (MBG); Mississippi bottoms, Shepherd, Pike Co., 29 Aug. 1914, *Davis 3565* (MBG); banks of the Mississippi, opposite St. Louis, July 1842, *Engelmann* (MBG).

Minnesota: shore, De Soto Lake, Itaska Park, Becker Co., 13 Aug. 1929, *Grant 3073* (G, MBG); fields, Collegeville, 29 July 1912, *Chandonnet* (MBG); Rockville, July 1896, *Campbell* (P); Swan Lake, Minneapolis, July 1892, *Ballard* (G).

Iowa: Ames, Sept. 1873, *Bessey* (G); Ames, Sept. 1909, *Pammel 78* (MBG); ledges, Boone Co., 1898, *Pammel 1806* (MBG); Grinnell, Aug. 1875, *Jones* (P); Grinnell, Aug. 1877, *Jones* (G, MBG); Decatur Co., 13 July 1903, *Anderson* (MBG).

Missouri: Medill, 24 Aug. 1920, *Bush 9165* (MBG, P); Palmyra, 5 Oct. 1914, *Davis 3578, 3590* (MBG); Oakwood, *Davis 3192, 3817* (MBG); St. Louis Co., 12 Aug. 1877, *Eggert* (MBG, P); Creve Coeur Lake, 14 Aug. 1927, *Kellogg 1131* (MBG); St. Louis, July 1839, *Lindheimer* (MBG); banks of Chouteau's Pond, St. Louis, Aug. 1841, *Engelmann* (MBG); south banks of Chouteau's Pond, St. Louis, July 1842, *Engelmann 337* (MBG); banks of River des Peres, near St. Louis, Sept. 1841, *Engelmann* (MBG); St. Louis, Aug. 1861, *Engelmann* (G); Allenton, 18 June 1896, *Kellogg* (MBG); Courtney, 31 Aug. 1904, *Bush 2214* (MBG); Webb City, *E. J. Palmer 197, 198, 1085* (MBG); Neck City, 4 Aug. 1916, *E. J. Palmer 10568* (MBG); Joplin, 10 July 1897, *Trelease 716* (MBG).

Manitoba: low ground, Muskeg Island, Lake Winnipeg, 11 Aug. 1884, *Macoun* (G).

North Dakota: peninsula of Lake Ibsen, 1 Aug. 1899, *Lunell* (G); Grand Forks, 10 July 1893, *Brannon 128* (MBG); edge of slough, Fairmount, 22 July 1912, *Bergman 2335* (MBG).

South Dakota: Brookings, 1 Aug. 1893, *Thornber* (MBG); Oakwood Lakes, Brookings Co., 27 July 1903, *Johnson* (MBG); Iroquois, 9 Aug. 1894, *Thornber* (G); Forestburg, 18 July 1910, *Visher 4439* (MBG).

Nebraska: Dickson's Bluffs on the Missouri, 12 July 1853, *Hayden* (MBG);

prairies, Middle Loup River, near Thedford, 8 Sept. 1893, *Rydberg 1515* (G); St. Paul, 24 July 1909, *Bates* (G); Lincoln, 9 July 1885, *Webber* (MBG); waste places, Nuckolls Co., Aug. 1899, *Hedgcock* (MBG).

KANSAS: Olathe, Aug. 1892, *Hitchcock* (MBG); wet places, Riley Co., 16 July 1895, *Norton 390* (G, MBG); banks of Joy Creek, about 8 km. from Osborne City, 11 July 1894, *Shear 202* (G); Reno Co., 24 July 1899, *White 174* (MBG).

OKLAHOMA: near Lamont, 2 Aug. 1913, *Stevens 1791* (G, MBG); Doby Springs, Harper Co., 20 Aug. 1927, *Stratton 400* (MBG); close to edge of Lake Ivanhoe, near Shattuck, 11 Oct. 1913, *Stevens 2901* (G).

TEXAS: 1.6 km. north of Canadian River, on Amarillo-Dalhart Road, Oldham Co., 27 Aug. 1921, *Ferris & Duncan 3513* (MBG).

SASKATCHEWAN: without locality, 1857–8, *Bourgeau* (G).

MONTANA: Hot Springs, Flathead Lake, 8 Sept. 1908, *Jones 8963* (P).

WYOMING: Goose Creek, 10 July 1896, *A. Nelson 2258* (G, MBG); Sheridan, 24 July 1901, *A. Nelson 8439* (MBG).

COLORADO: Wray, 11–13 Aug. 1919, *Eggleston 15551* (P); Timnath, 22 July 1901, *Osterhout* (P); Fort Collins, 7 July 1897, *Crandall 2014* (G); along Platte River, Denver, 16 Aug. 1910, *Eastwood 41* (G, MBG); foothills near Golden, 1 Aug. 1878, *Jones 523* (P); Brighton, Sept.–Oct. 1908, *E. L. Johnston 507* (MBG); Georgetown, 24 July 1878, *Jones* (P); Canon City, 1872, *Brandegee* (MBG).

NEW MEXICO: valley of the Mimbres, 1851, *Wright 1498* (ANSP, G).

ARIZONA: Flagstaff, 1891, *MacDougal 566* (NY); Hassayampa Creek, Fort Whipple, 6 June 1865, *Coues & Palmer 279* (MBG).

IDAHO: Boise, 18 Aug. 1911, *Clark 253* (G, MBG); Falk's Store, Canyon Co., 28 June 1910, *Macbride 304* (MBG).

UTAH, Salt Lake City, 18 June 1878, *Jones 487* (P); near Salt Lake City, 14 July 1902, *Pammel & Blackwood 3638* (G); American Fork Canyon, 3 Aug. 1880, *Jones 1487* (P).

NEVADA: Panaca, 5 Sept. 1912, *Jones* (P).

BRITISH COLUMBIA: Alberni, Vancouver Island, July 1915, *Carter* (G).

WASHINGTON: Meyers Falls, 20 Aug. 1902, *Kreager 469* (G); Alma, Okanogan Co., July 1897, *Elmer 537* (MBG, P); foot of Priest Rapids, 17 July 1903, *Cotton 1396* (G); Yakima region, 1882, *Brandegee* (MBG); Walla Walla, July 1898, *Savage, Cameron & Lenocker* (MBG); Prosser, 14 July 1929, *Gotfredson 90* (P).

OREGON: near Pendleton, 11 Sept. 1896, *Leiberg 2630* (G); Multnomah Co., July 1877, *T. Howell 292* (G); Mount Scott, Multnomah Co., 15 Aug. 1902, *Sheldon 11167* (G, MBG, P); low ground, Salem, 30 July 1917, *J. C. Nelson 1804* (G).

CALIFORNIA: near San Joaquin River, Louis Park, Stockton, 26 Sept. 1927, *Stanford 721* (P).

This rather distinct species shows a tendency to blend with several members of the *Verbenaca* in the region of the Middle States. Some botanists have regarded the variability in the compactness and the profusion of the inflorescence, as well as the tendency of the leaves to develop hastate lobes near the base, as being of nomenclatorial value. Unfortunately in the rather complete series of specimens at hand, the writer has not found any combination of characters varying greatly in one direction;

and, at the present time, sees no reason to maintain other than the specific category.

17. **V. simplex** Lehm. Ind. Sem. Hort. Hamb. 17. 1825; in Nova Acta K. Acad. Leop. (Pugill. Pl. 1: 37) **14**: 824. 1828; Linnaea **3**: Litt.-Ber. 10. 1828.

V. angustifolia Michx. Fl. Bor.-Am. **2**: 14. 1803, not *V. angustifolia* Mill. Gard. Dict. no. 15. 1768.

V. rugosa Muhl. ex Willd. Enum. Hort. Berol. 633. 1809, not *V. rugosa* Mill. Gard. Dict. no. 18. 1768, nor *V. rugosa* D. Don in Sweet, Brit. Fl. Gard. II. **4**: *pl. 318*. 1838.

Stems chiefly erect, branched above, branches ascending, sparsely pubescent or strigillose; leaves lanceolate or spathulate, tapering into a subsessile base, 3–10 cm. long, subacute or obtusish, serrate or serrulate, reticulately rugose above and occasionally scabrous, somewhat prominently veined beneath, glabrate or sparsely strigillose on both surfaces; spikes solitary at the apices of stems and branches, short-peduncled, strict, usually somewhat crowded; bracts lanceolate-subulate, commonly shorter than the calyx, glabrate or glabrous; fruiting calyx 4 (–5) mm. long, sparsely pubescent, lobes acuminate; corolla-tube scarcely longer than the calyx, with scattering hairs outside the throat; corolla-limb about 6 mm. broad; nutlets trigonous, 2.5 mm. long, raised-reticulate above, striate toward base; commissural faces fully as long as the nutlets, muriculate-scabrous.

Distribution: Ontario and Vermont, south to Florida, west to Oklahoma and Nebraska.

Specimens examined:

Ontario: rocky ground, Belleville, 20 June 1876, *Macoun 1305* (G).

Vermont: without locality, 5 July 1903, *Blanchard 26, 60* (G), *161* (NY).

Massachusetts: dry hillside, Sheffield, 27 Aug. 1902, *Hoffman* (G).

Connecticut: railroad cut, Fair Haven, 18 June 1886, *Harger* (G); New Haven, *Eaton* (G); New Haven, 26 June 1884, *Safford 216* (US).

New York: sandy field north of Tripoli, 25 July 1920, *Burnham* (G); Pine Plains, 1875, *Hoyeradt* (G).

New Jersey: Scotch Plains, 13 Aug. 1877, *Trelease* (MBG); Camden Co., 22 June 1871, *Parker* (G); Atco, 22 June 1871, *Redfield 6430* (MBG); Sicklerville, 21 June 1894, *Brinton* (G); Oakland, 25 July 1909, *Mackenzie 4213* (MBG).

Pennsylvania: without data, *Muehlenberg* (Bot. Mus. Berl.-Dahl. type of *V. rugosa*, MBG phot.); Philadelphia, *Nuttall* (G); Whiteland, Chester Co., 26 June 1910, *Bartram 1021* (G); vicinity of Conewago, 28 May 1889, *Small* (US); York Furnace, 28 June 1899, *MacElwee 760* (MBG, NY); Mercersburg, *Green* (G).

MARYLAND: Great Falls, 6 Aug. 1905, *House 1363* (MBG); Hurlock, 29 May 1919, *C. P. Smith 3186* (G).

DISTRICT OF COLUMBIA: Washington, 26 May 1889, *Sudworth* (G); Joy City, 19 June 1891, *Blanchard* (MBG).

VIRGINIA: Bluemont, 25 May 1905, *House 875* (US); open woods near Churchview, 5 June 1921, *Leonard & Killip 534* (US); north of Williamsburg, 17 June 1921, *Grimes 3738* (NY); Bedford Co., June 1873, *Curtiss* (MBG); Chilhowie, 4 Aug. 1892, *Small* (F, NY); about Cumberland Gap, Lee Co., 27 July 1892, *Small* (F, G, MBG, US); Blue Ridge, 22 July 1891, *Seymour 48* (G), *49* (MBG).

NORTH CAROLINA: near Chapel Hill, *Ashe* (US); Morgantown, 1872, *Ruger* (US); near Biltmore, 17 June 1897, *Biltmore Herbarium 4759b* (G, NY, US); Madison Co., 27 July 1880, *J. D. Smith* (US).

SOUTH CAROLINA: Abbeville District, July 1855, *Hexamer & Maier* (G).

GEORGIA: Dalton, 9 Aug. 1900, *Harper 385* (NY, US); Chickamauga Creek, near Ringgold, 6–12 Aug. 1895, *Small* (F, NY); between Taylor Ridge and Lafayette, 3 July 1900, *P. Wilson 161* (NY, US).

FLORIDA: without locality, 1842–49, *Rugel 127* (F, MBG, US).

ALABAMA: Cullman, 29 May 1892, *Mohr* (US); Blount Springs, 5 May 1898, *Baker* (P); Blountsville, 6 May 1898, *Baker* (US); Choctaw Co., 13–15 Oct. 1896, *Schuchert* (US).

MISSISSIPPI: Agricultural College, Oktibbeha Co., 11–17 Aug. 1896, *Pollard 1312* (F, G, MBG, NY, P, US).

OHIO: on limestone soil, Castalia, 27 July 1894, *Moseley* (G); Sandusky, 28 July 1894, *Moseley* (F, US); Oxford, 16 June 1910, *Overholts* (MBG).

WEST VIRGINIA: Shenandoah Junction, June 1891, *Millspaugh 865* (NY); along Roanoke River, south of Roanoke, 2 June 1891, *Small & Heller 432* (G); roadside, south of Williamsburg, 13 June 1921, *Grimes 3716* (G); Sweet Springs, 14 Sept. 1903, *Steele 314* (G, MBG, NY, US).

INDIANA: near boundary line to Galien, St. Joseph Co., 15 June 1911, *Nieuwland 2685* (MBG, US); about 3 km. west of Goldsmith, 9 July 1913, *Deam 13619* (MBG); about 1.6 km. west of Palmyra, 22 June 1916, *Deam 20357* (G, US).

KENTUCKY: without data, *Short* (NY); Stamping Ground, 29 May 1930, *Singer 178* (US); Smithfield, 30 May 1909, *Eggleston* (NY); Nicholasville, 8 June 1923, *McFarland 109* (MBG); Mammoth Cave, Edmonson Co., May 1899, *Palmer* (NY); Bowling Green, 21 May 1899, *Price* (MBG); near Franklin, 22 May 1926, *Anderson & Woodson 47* (MBG); Kuttawa, 27 Sept.–9 Oct. 1909, *Eggleston 5237* (MBG, NY).

TENNESSEE: Carter Co., 8 July 1880, *J. D. Smith* (US); Knoxville, *Ruth* (F, P), *731* (US), *740* (NY), *765* (MBG); roadside at base of Chilhowee Mountains, *Curtiss 1955* (F, G, MBG, NY); Chattanooga, 25 Aug. 1876, *Engelmann* (MBG); West Nashville, 26–27 May 1909, *Eggleston 4430* (MBG, NY, US); Kingston Spring, 5 Aug. 1897, *Eggert* (MBG); Hollow Rock, Carroll Co., 14 Aug. 1897, *Biltmore Herbarium 4759* (G, MBG, NY, US).

WISCONSIN: Baraboo, 1861, *Hale* (G, MBG).

ILLINOIS: Stony Island, June 1911, *Greenman 3640* (MBG); Stony Island, 25 June 1914, *H. H. Smith 5923* (G, MBG); near 91st Street, Chicago, 28 July 1907, *Greenman 1981* (MBG); South Chicago, 18 July 1913, *H. H. Smith 5670* (G); Rock Island, 17 Aug. 1866, *Engelmann* (MBG); East St. Louis, 9 July 1898, *Norton* (MBG); bluffs near Prairie du Pont, 20 June 1876, *Eggert* (MBG); Red Bud, 3 June 1888, *Pammel* (MBG); Shawneetown, 26 May 1919, *E. J. Palmer 15262* (MBG); Mound City, June 1859, *Vasey* (G).

Iowa: without locality, 17 July 1875, *Arthur 24* (MBG); Cedar Falls, 12 July 1926, *Pammel 272* (G); Iowa City, *Hitchcock* (MBG); Columbus Junction, 27 Aug. 1899, *Pammel 1699* (MBG).

Missouri: Hannibal, 27 June 1917, *Davis 3588* (MBG); Ethel, 11 June 1915, *Bush 7586a* (MBG); Silex, 29 May 1915, *Davis 4552* (MBG); prairie, St. Louis, May 1833, *Engelmann 336* (MBG); banks of Mississippi above St. Louis, Oct. 1841, *Engelmann* (MBG); St. Louis, Sept. 1841, *Engelmann* (G, US); mineral region southwest of St. Louis, June 1845, *King* (MBG); Pacific, 13 June 1897, *Trelease 713* (MBG); Pacific, 3 June 1918, *Greenman 4125* (MBG); Gray Summit, 16 June 1927, *Kellogg 1130* (MBG); Allenton, 6 July 1911, *Letterman* (MBG); near Sulphur Springs, 29 May 1927, *Steyermark 292* (MBG); Crystal City, 14 May 1887, *Trelease* (MBG); Washington, 25 June 1888, *Pammel* (MBG); Victoria, 8 July 1890, *Hitchcock* (MBG); Jefferson Co., 20 June 1876, *Eggert* (MBG); near Hillsboro, June, *Riehl 456* (MBG); Hillsboro, 24 May 1885, *F. Wislizenus 280* (MBG); near St. Genevieve, 27 May 1928, *Greenman 4578* (MBG); Jerome, 24 May 1914, *Kellogg 496* (MBG); Sheffield, 17 June 1915, *Bush 7647* (G, MBG, US); Westport, 17 May 1896, *Bush 914* (US); Independence, 1 June 1895, *Tindall* (MBG); south of Cedar Gap, 22 May–3 June 1911, *Lansing 2976* (F, G); about 2 km. west of Mansfield, 5–12 June 1911, *Lansing 3135* (F, G); Springfield, 31 July 1892, *Dewart 42* (MBG); Willard, 24 July 1919, *Blankinship* (P); limestone barrens, Ash Grove, 24 Aug. 1912, *Standley 9336* (US); Carterville, 8 July 1910, *E. J. Palmer 2981* (MBG); Webb City, *E. J. Palmer 200, 3319* (MBG); Swan, 24 Sept. 1899, *Bush 450* (MBG); Galena, Stone Co., 27 May 1914, *E. J. Palmer 5769* (MBG); Gainesville, 26 June 1928, *E. J. Palmer 34766* (MBG); Eagle Rock, 24 June 1897, *Bush 206* (MBG, US); Noel, McDonald Co., 9 Sept. 1913, *E. J. Palmer 4232* (MBG).

Arkansas: Beaver Station, Eureka Springs, *Glatfelter* (MBG).

Nebraska: Wahoo, June 1890, *Rydberg 154* (NY).

Kansas: Lawrence, *Stevens* (US); between Pleasanton and Prescott, 20 June 1929, *Rydberg & Imler 120* (MBG); sterile soil, Anderson Co., 1896, *Hitchcock 791* (G, MBG, NY, US); Mound City, 18 July 1887, *Kellerman* (MBG).

Oklahoma: near Miami, 26 Aug. 1913, *Stevens 2299* (G, NY); near Copan, 15 Aug. 1913, *Stevens 2080* (G); Foyil, 5 Aug. 1894, *Bush 433* (MBG); on creek bank, near Pawhuska, 9 Aug. 1913, *Stevens 1980* (G); Caddo, 20 June 1891, *Sheldon 49* (US); near Idabel, 18 May 1916, *Houghton 3622, 3646* (G, MBG).

This species appears to be very closely related to *V. hastata*. In its typical form, it is readily distinguished by its elongate spikes and narrow leaves. Often, however, intermediate forms occur between the two, making it somewhat difficult to find clear lines of demarcation between them.

18. V. Orcuttiana Perry,[18] n. sp.

[18] **V. Orcuttiana** Perry, spec. nov., herbacea verisimiliter perennis; caulibus erectis quadrangularibus sparse pubescentibus ramosis; foliis lanceolato-ellipticis spathulatisve in petiolum alatum attenuatis 4–6 cm. longis grosse serratis lineato-rugosis adpresso-pubescentibus supra subtusque reticulatis dense patento-hirtellis; spicis pedunculatis compactis elongatisque; bracteis lanceolato-acuminatis sparse ciliatis nervo medio et margine decurrentibus calyce brevioribus; calyce 4 mm. longo

Stems several from a common base, 4-angled in cross-section, glabrous or very sparsely hirtellous, branching; leaves lanceolate-elliptical to spathulate, tapering into a margined petiole (1–2 cm. long), 4–6 cm. long, decussate, coarsely serrate, rugose and appressed-pubescent above, more densely spreading-pubescent or hirtellous beneath and prominently veined; spikes pedunculate, solitary or somewhat panicled, strict, mostly dense, elongate; rhachis more or less angulate; bracts lanceolate-acuminate, shorter than the calyx, midrib and margins more or less decurrent along the rhachis, sparsely ciliate; calyx 4 mm. long, appressed-pubescent and finely glandular, teeth short-subulate or acuminate, more or less connivent above the schizocarp; corolla-tube about as long as the calyx; corolla-limb 3–4 mm. broad; nutlets trigonous, 2 mm. long, raised-reticulate at the apex, striate toward the base; commissural faces extending to the tip of the nutlet, muriculate-scabrous.

Distribution: Lower California.
Specimens examined:
MEXICO:
LOWER CALIFORNIA: Pinery, 27 July 1883, *Orcutt* (US); Hanson's Ranch, 29 July 1883, *Orcutt* (G, NY, US); table-lands, Hanson's Ranch, 30 July 1883, *Orcutt 909* (G TYPE); mountains, northern Lower California, 8 July 1885, *Orcutt* (US); Sierra Juarez, 12 July 1924, *Gallegos 2342* (US).

This species, which has been passing as *V. litoralis*, is much like *V. neomexicana* var. *xylopoda* in the finely glandular spike and the angle of insertion of the flowers. It differs, however, in the shorter nutlets, the smaller corollas, and the type of the pubescence. In *V. Orcuttiana*, the trichomes are short and somewhat hirtellous and the pubescence of the inflorescence is closely appressed. In gross habit, it is scarcely to be distinguished from *V. simplex*, but the latter has somewhat harsher pubescence and larger non-glandular flowers.

19. V. stricta Vent. Hort. Cels. 53, *pl. 53.* 1800.
V. Alopecurus Cav. Descr. 68. 1802.

adpresso-pubescente tenuiter glanduloso; calycis dentibus breviter subulatis vel acuminatis; corollae tubo vix exserto; corollae limbo 3–4 mm. lato; coccis subtrigonis 2 mm. longis dorso striatis apice elevato-reticulatis; commissura muriculata.—Collected on table-lands, Hanson's Ranch, Lower California, 30 July 1883, *Orcutt 909* (G), TYPE.

V. rigens Michx. Fl. Bor.-Am. **2:** 14. 1803.
V. cuneifolia Raf. Med. Repos. N. Y. II. **5:** 360. 1808.
V. stricta β ? mollis Torr. Ann. Lyc. N. Y. **2:** 234. 1827.
V. mollis Raf. Atl. Jour. 146. 1832.
V. stricta f. *roseiflora* Benke, Rhodora **34:** 10. 1932.
V. stricta f. *albiflora* Wadmond, Rhodora **34:** 19. 1932.

Stems 3–12 dm. tall, subterete, simple or branched above, rather densely hirsute; leaves ovate or suborbicular, 6–10 cm. long, sessile or nearly so, sharply and mostly biserrate, thickish, hirsute and rugose above, densely hirsute-villous and prominently veined beneath; spikes solitary or several, short-pedunculate, thick, usually quite dense both in flower and in fruit; bracts lanceolate-subulate, approximately as long as the calyx, hirsute, ciliate; calyx 4–5 mm. long, densely hirsute, lobes acuminate; corolla protruding slightly beyond the calyx, pubescent without; corolla-limb 8–9 mm. broad; nutlets trigonous, 2.5 mm. long, raised-reticulate above, strongly striate below; commissural faces reaching tip of nutlet, muriculate or almost smooth.

Distribution: eastern and central United States, from Pennsylvania westward through the Rocky Mountains. Probably introduced into other localities.

Specimens examined:

(Herb. Bot. Gard. Madrid TYPE of *V. Alopecurus*, MBG phot.).

MASSACHUSETTS: Fall River, 2 Sept. 1903, *Sanford* (G).

CONNECTICUT: waste ground, Nangatuck, 19 July 1908, *Blewitt 14* (G); Bridgeport, 27 Aug. 1892, *Eames* (G).

NEW YORK: pasture south of Pulpit Rock, Ithaca, 2 Aug. 1919, *A. J. Eames 12797* (G).

NEW JERSEY: ballast, New Durham, 15 July 1893, *Van Sickle* (US).

PENNSYLVANIA: along Lincoln Highway at Gap, Lancaster Co., *Urban* (G); vicinity of Conewago, Sept. 1892, *Small* (NY); Conewago, Sept. 1892, *Heller 638* (US).

OHIO: Dayton, *Short* (MBG).

MICHIGAN: Constantine, 2 July 1923, *Fisher 19* (MBG); Pine Lake, Charlevoix Co., 18 Aug. 1917, *Ehlers 642* (P).

INDIANA· East Chicago, 10 Aug. 1910, *Lansing 2810* (G); Lake Maximkuckee, 9 Aug. 1889, *Evermann 970* (US); sand pit northeast of Winona Lake, 2 Aug. 1897, *Deam* (MBG); west of Palmyra, 22 June 1916, *Deam 20357a* (G).

KENTUCKY: waste places, Hickman, 14 Aug. 1897, *Biltmore Herbarium 3653a* (NY); Calvert City, Marshall Co., 16–19 June 1909, *Eggleston 4837* (NY); Wickliffe, 16 Aug. 1923, *McFarland & Anderson 253* (MBG).

TENNESSEE: Hickmann, *Gattinger* (US); Henderson, June 1892, *Bain 328* (NY).

WISCONSIN: Mirror Lake, 15 July 1903, *Eggert* (MBG); Waupaca, 1907, *Garesche* (MBG); Trempeleau, 1861, *Hale* (G); Oregon road, Madison, 29 July 1889, *Trelease* (MBG).

ILLINOIS: Stony Island, Chicago, *H. H. Smith 5645, 6028* (G, MBG), *5952* (G); Romeo, 26 July 1897, *Umbach* (MBG); Starved Rock, La Salle Co., June–Sept. 1921, *Thone 88* (MBG); Oquawka, 1872, *Patterson* (G, NY); Bloomington, July 1886, *Robinson* (G); Carthage Township, 2 Sept. 1916, *Gates 9994* (MBG); Decatur, 19 June 1896, *Gleason 377* (G); Athens, Aug. 1863, *Hall* (MBG); East Hannibal, 13 June 1913, *Davis 16* (MBG); Shepherd, 25 June 1915, *Davis 6370* (MBG); Mississippi River, bluffs north of Alton, 4 Aug. 1910, *Sherff* (G); Bonpas Township, 15 July 1925, *Ridgway 2431* (MBG); E. St. Louis, 28 July 1900, *Eggert* (MBG); Grand Tower, 22 Aug. 1900, *Gleason* (G).

MINNESOTA: Perham, Ottertail Co., 8 Aug. 1912, *Chandonnet* (MBG); St. Anthony, 7 July 1888, *Schuette* (G, NY); Willmar, July 1892, *Frost* (G); Morton, July 1890, *MacMillan* (P); Lake City, 28 July 1883, *Manning* (G); Winona Co., Aug. 1901, *Holzinger* (NY); Houston Co., July 1912, *Freiberg* (MBG).

IOWA: Fayette Co., 12 July–4 Sept. 1904, *Fink 251* (US); Hawkeye, Aug. 1896, *Gardner 583* (NY); Cerro Gordo Co., 14 Aug. 1899, *Jones* (MBG); Ames, 29 Aug. 1896, *Pammel 85* (G, MBG, NY); Grinnell, Aug. 1877, *Jones* (NY, P); Mount Pleasant, 7 July 1898, *Ball 1585* (MBG); Keosauqua, Aug. 1920, *Graves 1947* (MBG); Bentonsport, July 1920, *Graves 1994* (MBG).

MISSOURI: suburbs of Hannibal, *Davis 1202, 1513, 2791, 2960, 2962, 3227, 3589, 4461, 4487* (all MBG); Chain of Rocks, Aug. 1915, *Beckwith 48* (MBG); St. Louis Co., 15 July 1872, *Redfield 522* (MBG); St. Louis, Aug. 1838, *Riehl 196* (MBG, NY); St. Louis, Aug. 1841, *Engelmann* (G); Allenton, *Letterman* (MBG); Williamsville, Wayne Co., 27 June 1914, *E. J. Palmer 6107* (MBG); Jerome, 16 June 1914, *Kellogg 498* (MBG); Warsaw to Linn Creek, Camden Co., July–Aug. 1913, *Emig 107* (MBG); Cole Camp, Benton Co., 12 July 1897, *Trelease 717* (MBG); railroad embankments, Mansfield, 5–12 June 1911, *Lansing 3164* (G); Randolph, 17 July 1898, *Mackenzie 261* (MBG); Independence, 26 June 1895, *Bush 475* (MBG, NY); Willard, 9 July 1919, *Blankinship* (P); Carterville, 8 July 1910, *E. J. Palmer 2980* (MBG); Webb City, 3 Aug. 1902, *E. J. Palmer 199* (MBG); Turkey Creek, Joplin, 10 July 1897, *Trelease 718* (MBG); Swan, 25 Sept. 1899, *Bush 570* (MBG).

ARKANSAS: waste places, *Harvey 1958* (G, NY); Big Lake, 20–22 June 1911, *McAtee 2053* (NY, US); Jonesboro, Craighead Co., 4 July 1927, *Demaree 3553* (MBG); Fayetteville, *Harvey 61* (MBG); Fort Smith, 1853–4, *Bigelow* (US).

SOUTH DAKOTA: Big Stone Lake, Roberts Co., July 1922, *Over 14386* (US); Windsor Township, Brookings Co., 27 July 1903, *Johnson* (MBG); Forestburg, 3 July 1910, *Visher 4450* (MBG); 16 km. south of Interior, 29 June 1929, *E. J. Palmer 37627* (G, MBG); near Fort Meade, Black Hills, 19 June 1887, *Forwood 299* (US); canyons, Lead, 9 Aug. 1913, *Carr 118* (G, MBG, NY, US); Rapid City, 22 July 1912, *Visher 1507* (NY); Hot Springs, 3 Aug. 1892, *Rydberg 932* (US).

NEBRASKA: Lincoln, 27 June 1885, *Webber* (MBG); near Central City, 26 Aug. 1926, *Heller 14290* (MBG); South Fork of Platte, July 1856, *H. Engelmann* (G, MBG); Alma, 21 June 1897, *Pammel* (MBG); Anselmo, 8 July 1889, *Webber* (US); Broken Bow, 7 July 1897, *Pammel* (MBG); Callaway, 27 June 1901, *Bates* (G); Dismal River, south of Thedford, 27 June 1893, *Rydberg 1422* (G, NY, US); North Platte, July 1896, *Plank* (NY); Ogallala, 16 June 1925, *Jones* (P).

KANSAS: Pottawatomie Co., 1895, *Hitchcock 972* (US); prairie, Riley Co., 26 July 1895, *Norton 391* (G, MBG, NY, US); Concordia, 24 July 1929, *Benke 5164* (G, NY), forma *roseiflora;* hill 8 km. from Osborne, 11 July 1894, *Shear 191* (G); Florence, 28–30 July 1903, *Griffiths 5050* (US); vicinity of Caney, 29 June 1929, *Rydberg & Imler 433* (MBG, NY); Syracuse, 28 July 1893, *C. H. Thompson 154* (G, MBG, NY, US).

Oklahoma: Verdigris, 2 Aug. 1894, *Bush 435* (MBG); 12 km. west of Pawnee, 27 July 1927, *Stratton 249* (MBG); near Tonkawa, 5 Aug. 1913, *Stevens 1865* (G); Doby Springs, 20 Aug. 1927, *Stratton 403* (MBG); near Shattuck, 11 Oct. 1913, *Stevens 2930* (G); Norman, 10 Oct. 1914, *Emig 365* (MBG); near Granite, 17 June 1913, *Stevens 1034* (G); Arbuckle Mountains near Davis, 23 June 1917, *Emig 787* (MBG); vicinity of Fort Sill, 16 Aug. 1916, *Clemens 11748* (MBG); near Cache, 25 June 1913, *Stevens 1354½* (G, MBG); near Grant, 2 June 1916, *Houghton 4000* (G, MBG, NY).

Texas: Lipscomb, 1 July 1903, *Howell 64* (US); prairies, near Canadian, 11 Aug. 1900, *Eggert* (MBG); Dallas, *Reverchon* (G, NY), *735* (MBG).

Montana: bottoms, Crow Agency, 14 July 1901, *Blankinship* (G).

Wyoming: Whalen Canyon, 16 July 1894, *A. Nelson 538* (G); Hartville, 20 July 1894, *A. Nelson 505* (G, MBG).

Colorado: Wray, 1–4 July 1919, *Eggleston 15224* (MBG); Denver, 2 Sept. 1910, *Eastwood 90* (G, MBG, US).

New Mexico: creek bottom, Santa Fe, 1847, *Fendler 597* in part (ANSP, G).

Washington: Meyers Falls, 20 Aug. 1902, *Kreager 475* (G, NY, US).

A very distinct species somewhat incapable of sharp delimitation on account of the tendency to hybridize with neighboring species. Normally it is recognized by its stout compact spike, imbricated flowers, and ovate-orbicular sessile leaves.

20. V. MacDougalii Heller, Bull. Torr. Bot. Club **26**: 588. 1899.

V. MacDougalii mut. *rosella* Cockerell, Am. Nat. **36**: 809. 1902.

Stems 3–8 dm. tall, stout, obtusely four-angled, simple or occasionally branched, cinereous-green, hirsute-pubescent; leaves oblong-elliptical or elongate-ovate, 6–10 cm. long, short-petiolate or narrowed into a subpetiolar base, coarsely and irregularly serrate-dentate, hirtellous, rugose and minutely pustulate above, densely pilose-pubescent and prominently veined beneath; spikes solitary or sometimes several, short-pedunculate, thick, comparatively dense both in flower and in fruit; bracts lanceolate-subulate, for the most part noticeably longer than the calyx, pubescent, ciliate; calyx 4–5 mm. long, rather densely pubescent, lobes very obtuse, terminating in short subulate teeth; corolla-tube scarcely protruding beyond the calyx; corolla-limb 6 mm. broad; nutlets trigonous with convex back, 2.5 mm. long, raised-reticulate toward the distal end, strongly or faintly striate below; commissural faces reaching tip of nutlet, muriculate or almost smooth.

Distribution: southern Wyoming to New Mexico and Arizona.

Specimens examined:

WYOMING: Platte Canyon, Laramie Co., 2 July 1901, *A. Nelson 8354* (MBG).

COLORADO: Palmer Lake, 22 July 1895, *Osterhout* (NY); La Veta, 14 July 1896, *Shear 3577* (NY); Cucharas Valley, near La Veta, 20 July 1900, *Vreeland 636* (NY); Stonewall, July 1912, *Beckwith 138* (NY); Arboles, 10 July 1899, *Baker 565* (F, G, MBG, NY, P, US).

NEW MEXICO: without locality, 1847, *Fendler 597* in part (MBG); Vermejo Park, Colfax Co., 31 Aug. 1913, *Wooton* (NY); vicinity of Ute Park, Colfax Co., 2 Sept. 1916, *Standley 14224* (NY); foot of Baldy Mountain, near Elizabethtown, Oct. 1898, *St. John* (US), mut. *rosella;* near Sierra Grande Union, 18 June 1911, *Standley 6065* (US); Jicarilla Apache Reservation, near Dulce, 20 Aug. 1911, *Standley 8239* (US); southeast of Cuba, 22 Aug. 1915, *Read 19* (US); Sandia Mountains, 15 July 1914, *Ellis 258* (MBG, US); Santa Fe Co., 10 July 1847, *Edwards* (NY); Santa Fe Co., 1889, *Brandegee* (MBG); Santa Fe Co., 20 July 1898, *Greene 77* (NY); Santa Fe Canyon, 3 Oct. 1913, *Rose, Fitch & Parkhurst 17717* (US); Winsar's Ranch, Pecos River National Forest, 6 July 1908, *Standley 4223* (F, G, MBG, NY, US); near Pecos, 15 Aug. 1908, *Standley 4927* (F, G, MBG, NY, US); west of Las Vegas, *St. John* (P); Las Vegas, 26 June 1893, *Mulford 39* (MBG); vicinity of Las Vegas, *Anect 57* (G), *211* (NY); mountains west of Grant's Station, 2 Aug. 1892, *Wooton* (NY, US); White Mountains, Lincoln Co., 26 July 1897, *Wooton 208* (MBG, NY, P, US); Cloudcroft, 1912, *Stearns 342, 358* (US); Cloudcroft, Aug. 1920, *Schulz 255* (NY); Mescalero Reservation, Sacramento Mountains, 21 July 1905, *Wooton* (US).

ARIZONA: Clark's Valley, 1 Aug. 1883, *Rusby* (NY, US); South Fork, Little Colorado River, Apache Forest, 23 Aug. 1920, *Eggleston 17106* (NY); 16 km. south of Rowe's Point on the Grand Canyon, 5 Nov. 1899, *Ward 11* (US); Flagstaff, 29 Aug. 1884, *Jones* (P); vicinity of Flagstaff, 8 July 1898, *MacDougal 249* (ANSP, F, G, NY TYPE); open pines, Flagstaff, 16 Aug. 1922, *Hanson A148* (F, MBG).

UTAH: Mammoth Creek, near head of Sevier River, 10 Sept. 1894, *Jones 6026* (MBG, NY, P).

This southwestern representative of *V. stricta* is readily distinguished by the short-petiolate elongated leaves, the compact spikes, and the floral bracts surpassing the calyx.

21. V. macrodonta Perry,[19] n. sp. Pl. 14.

[19] **V. macrodonta** Perry, spec. nov., herbacea (basi ignota) verisimiliter perennis; caule 1–1.5 m. alto erecto hirsuto-hispidulo ramoso; foliis elongato-ovatis basi cuneata in brevem petiolum alatum attenuatis 10–14 cm. longis biserratis vel mucronulato-denticulatis supra scabro-hirsutis et inconspicue pustulatis subtus reticulatis hirsutis; spicis paniculatis glanduloso-hirsutis basi foliolatis compactis deinde elongatis basi laxisque; bracteis lineari-lanceolatis subulatis ciliatis calyci subaequantibus; calyce 5 mm. longo glanduloso aliquantulum viscido-pubescente; calycis dentibus 1.5 mm. longis subulatis; corollae tubo paulo exserto extus glabro vel puberulo; corollae limbo 5–6 mm. lato; coccis subtrigonis 2 mm. longis dorso sulcatis superiore parte tenuiter scrobiculatis; commissura muriculata.—Collected on the road from Miraflores to San Bernardo Ranch in Sierra La Laguna, Lower California, about 750 m. alt., 20 Jan. 1906, *Nelson & Goldman 7425* (MBG), TYPE.

Stem 1–1.5 m. tall, erect, branching, hirsute-hispidulous; leaves elongate-ovate with cuneate base narrowed into a short (1–2 cm. long) margined petiole, 10–14 cm. long, coarsely and sharply biserrate-dentate with mucronate teeth, rugose with veins impressed and scabrous-hirsute above with minutely pustulate hairs, prominently veined and hirsute beneath; spikes panicled, subtended by leafy bracts, dense before anthesis, becoming elongated and open in fruit, glandular-hirsute; floral bracts lanceolate-linear, approximately equalling the fruiting calyx, subulate, ciliate; calyx 5 mm. long, glandular, somewhat viscid-pubescent, teeth 1.5 mm. long, subulate; corolla-tube protruding a little beyond the calyx, glabrous or puberulent without; corolla-limb 5–6 mm. broad; nutlets trigonous, 2 mm. long, shallowly scrobiculate on the upper half, tending to be sulcate toward the base; commissural faces muriculate.

Distribution: Lower California.

Specimens examined:

Mexico: Lower California: road from Miraflores to San Bernardo Ranch in Sierra La Laguna, about 750 m. alt., 20 Jan. 1906, *Nelson & Goldman 7425* (MBG type, US).

Verbena macrodonta is a coarse plant with large thickish leaves and open inflorescence, in a measure similar to *V. MacDougalii*, but differing in its less strict habit, somewhat remote fruits, more glandular calyces, and shorter plumper nutlets.

22. **V. prostrata** R. Br. in Ait. Hort. Kew. ed. 2, 4: 41. 1812.

V. lasiostachys Link, Enum. Hort. Berol. 2: 122. 1822.

Stems at first erect or ascending, at length spreading and diffusely branched, sparsely villous; leaves ovate or oblong-ovate with cuneate base tapering into a margined petiole, 5–10 cm. long, commonly 3-cleft, coarsely and irregularly serrate-dentate with apiculate teeth, or incised, veins impressed above, more or less conspicuous below, both surfaces pilose to sparsely villous; spikes solitary or more often loosely paniculate, dense before anthesis, becoming elongated and open in fruit; bracts lanceolate-subulate, not longer than the calyx, villous and at times finely glandular; calyx 4–5 mm. long, villous or glandular-hirsute, subtruncate, the distal end connivent above the schizocarp, teeth subulate; corolla-tube a little longer than the calyx, very

sparsely pubescent outside or apparently glabrous; corolla-limb 3–5 mm. broad; nutlets oblong-trigonous with convex back, 2–2.5 mm. long, slightly thicker at the distal end, raised-reticulate above, striate below, often with striae fading out toward the base; commissural faces more or less muricate, approximately reaching the tip of the nutlet.

Distribution: Oregon and California.

Specimens examined:

OREGON: dry bank along railroad, about 1.5 km. north of Comstock, 18 June 1919, *J. C. Nelson 2669* (G); banks of Umpqua at Roseberg, 2 June 1928, *Thompson 4412* (MBG); Glendale, 19 June 1902, *Jones* (P); Pleasant Creek, near Wimer, 26 July 1892, *Hammond 322* (MBG, NY, US); Grant's Pass, 24 June 1884, *T. Howell 174* (US); Grant's Pass, 3 July 1887, *T. Howell* (F), *1249* (MBG); gravel bar about 5 km. above mouth of Rogue River, 8 July 1919, *Peck 8702* (G, MBG, NY); in clearing about hotel, Agness, 22 June 1917, *J. C. Nelson 1429* (G); Dryden, 16 June 1904, *Piper 6160* (US); near Medford, Aug. 1922, *Epling 5445* (MBG); south of Ashland, 19 May 1898, *Applegate 2228* (US).

CALIFORNIA: near Yreka, Siskiyou, 19 June 1876, *Greene 860* (F, G, MBG, NY); Yreka, 2 July 1910, *Butler 1621* (MBG, P, US); Mount Shasta, 13–27 July 1892, *Palmer 2529a* (US); Soda Springs, Nevada Co., 30 July 1881, *Jones 2598* (P); Round Valley, Mendocino Co., 20 May–20 June 1898, *Chestnut* (US); near Clear Lake, 1865, *Torrey 417* (G, NY); Clear Lake, Lake Co., 12 July 1929, *Blankinship* (MBG); southern slope of Mount Sanhedrin, Lake Co., 19 July 1902, *Heller 5919* (G, MBG, NY, P, US); west of Windsor, near Russian River, Sonoma Co., 27 June 1902, *Heller 5785* (F, G, MBG, NY, P, US); Oak Knoll, 5 May 1901, *Braunton 378* (US); Irishtown, Amador Co., June 1893, *Hansen 964* (MBG); West Point Bridge, Calaveras Co., 7 July 1896, *Hansen 1823* (US); Stanford University, Santa Clara Co., April 1898, *Abrams* (P); San Jose, 14 July 1899, *Pammel 187* (MBG); Santa Cruz, 21 June 1881, *Jones* (G, P); in pine woods, Pacific Grove, 25 May 1903, *Heller 6778* (F, G, MBG, NY, P, US); Carmel Bay, Sept. 1902, *Elmer 4045* (G, P); Monterey, *Hartweg 1924* (G, NY); Monterey, Aug. 1917, *Parish 11590* (P); Santa Lucia Mountains, May 1898, *Plaskett 142* (NY, US); San Antonio River, 1880, *Vasey* (US); Wood's Creek, Fresno Co., 19 June 1910, *Clemens* (P); San Luis Obispo, 26 June 1876, *Palmer 342* (MBG, NY, US); San Luis Obispo Co., 19 June 1887, *Summers* (MBG, P); Santa Barbara Co., 1865, *Torrey 416* (G, NY); Santa Barbara, May 1902, *Elmer 3846* (MBG, P, US); seep, base of ocean bluffs, 32 km. northwest of Santa Barbara, 26 March 1925, *Munz 9295* (P); Sulphur Mountain Spring, Ventura Co., 1–2 June 1908, *Abrams & McGregor 5* (G, NY, US); Ventura, 13 April 1923, *Kendall* (P); San Buenaventura, March 1861, *Brewer 229* (US); Los Angeles, 1860–62, *Brewer 31* (G, US); Los Angeles, 29 May 1891, *Fritchey 29* (MBG); near Mesmer, 10 June 1917, *Johnston 1320* (P, US); near Pasadena, June 1893, *Haynes* (P); San Antonio Canyon, 28 June 1917, *Johnston 1608* (P); edge of woods, Palomar Mountain, 11 Aug. 1918, *Spencer 994* (G, P); wayside, Mesa Grande, 2 June 1919, *Spencer 1164* (G); Spencer Valley, near Julian, San Diego Co., 20 June 1903, *Abrams 3787* (F, G, MBG, NY, P); bottom of canyon south of "Lemon Tank," west coast, San Clemente Island, 10 April 1923, *Munz 6734* (P).

Although, from the original publication, one would naturally

infer that *V. prostrata* is Aiton's species, it is in all probability Robert Brown's. Aiton, in his acknowledgments (postscript to the fifth volume of Hortus Kewensis), mentions the new matter added by his friend Robert Brown, some without reference to his name; more tangible evidence is furnished by Schauer, who, in his monograph, indicates the specimen at Kew as *V. prostrata* R. Br.

The species is comparatively easy to distinguish by its decumbent habit, soft villous pubescence, and elongated spikes. It closely resembles *V. robusta*, which is much harsher and of limited distribution.

The following specimens differ from the species in having scarcely glandular inflorescence and fruiting calyx only 2.5–3 mm. long shortly conniving beyond the fruit:

California: Three Rivers, Tulare Co., 9 July 1904, *Culbertson 4210* (MBG, P); San Bernardino, Sept. 1886, *Parish & Parish 969* (F, US); near San Bernardino, May 1894, *Parish 2819* (MBG, P); Inglewood, Los Angeles Co., 31 May 1902, *Abrams 2481* (P); San Diego Co., 1875, *Palmer 309* (G, MBG); southern California, 1876, *Parry & Lemmon 342* (NY).

23. **V. robusta** Greene, Pittonia **3**: 309. 1898.

Stems 6–9 dm. high, erect, paniculately branched above, glabrate or sparsely hirsute; leaves ovate or oblong-ovate with cuneate base tapering into a margined petiole, 4–7(–10) cm. long, usually 3-cleft, irregularly serrate-dentate with apiculate teeth, or incised, rugose and scabrous-pubescent above, less harshly pubescent beneath with veins prominently reticulate; spikes often crowded, subsessile, usually dense but occasionally elongated; bracts lanceolate-subulate, more or less exceeding the calyx in length, densely glandular-hirtellous; calyx 4 mm. long, densely glandular-hirsute, lobes obtusish, terminating in very unequal acuminate-subulate teeth; corolla-tube a little longer than the calyx, puberulent without; corolla-limb 3–4 mm. broad; nutlets oblong-trigonous, 2–2.5 mm. long, raised-reticulate above with striae fading out toward the base; commissural faces more or less muricate, approximately extending to the tip of the nutlet.

Distribution: California and Lower California.
Specimens examined:

California: vicinity of Ione, Dec. 1904, *Braunton 1263* (MBG, NY); Tiburon, Marin Co., 26 July 1900, *Eastwood* (G); valley back of Berkeley, 23 Oct. 1880, *Engelmann* (MBG); West Berkeley, May 1887, *Greene* (US); salt marshes, Oakland, Sept. 1886, *Congdon* (G); Temescal, Alameda Co., Aug. 1891, *Michener & Bioletti 123* (G); Crystal Springs Lake, San Mateo Co., July 1903, *Elmer 4950* (MBG, P, US); San Luis Obispo, 1876, *Palmer 341½* (F, G, NY, US); west Sherman Canyon, 18 June 1901, *Braunton 99* (US); Valdez Bay, Santa Cruz Island, 5 Sept. 1927, *Jones* (P); sandy soil near coast, Santa Catalina Island, 19 July 1915, *Macbride & Payson 850* (G); Santa Catalina Island, 20–25 July 1917, *Eastwood 6500* (US); dry streambed, pebbly beach canyon, Santa Catalina Island, 13 May 1928, *Dunkle 1955* (P); Avalon, Santa Catalina Island, Sept. 1896, *Trask* (MBG); Avalon, May 1897, *Trask* (F, US); Avalon, Aug. 1901, *Trask* (NY); Avalon, 28 April 1914, *Carlson* (US); Avalon, 13 June 1915, *Carlson* (G, MBG); Jamuel Valley, San Diego Co., 26 June 1875, *Palmer* (G), *310* (F, MBG, NY).

Mexico: Lower California: near Rancho Salina, foot of Guatay Grade, about 6 km. south of Rio Guadalupe, 11 Sept. 1929, *Wiggins & Gillespie 3977* (MBG); Santa Tomas, 15 July 1885, *Orcutt 1301* (MBG, US).

Verbena robusta has been much confused with the nearly related *V. prostrata*, but is quite readily distinguished from the latter by the brighter green color of the herbage, the scabrous upper surface of the leaves, and the usually dense spikes. Moreover, the mature calyx lacks the marked tendency toward subconnivent lobes, a characteristic of *V. prostrata*. The schizocarps of the two are very much alike. The collection *Orcutt 1301* has a greatly elongated inflorescence and the leaves are not particularly scabrous. The specimens *Braunton 99* and *1263* show unusually long floral bracts. These are probably atypical phases of the species or possibly hybrids.

24. **V. xutha** Lehm. Del. Sem. Hort. Hamb. 7, 8. 1834; Linnaea **10**: Litt.-Ber. 115. 1835–6.

V. strigosa Hook. Comp. Bot. Mag. **1**: 176. 1836, not *V. strigosa* Cham. Linnaea **7**: 256. 1832.

V. Lucaeana Walpers, Rep. **4**: 23. 1844–48.

Stems upright, 6–10 dm. tall, branched, hirsute-hispid; leaves oblong or broadly ovate in outline, 5–8(–12) cm. long, incised-pinnatifid or more often trifid with segments coarsely dentate, the lateral much smaller than the middle segment and close to the sessile base of the blade, strigose above, canescent and spreading-hirsute below, trichomes particularly prominent along the somewhat paler midrib and veins; spikes elongate, somewhat strict, not compact except at anthesis, short-pedunculate; bracts

lanceolate-subulate, subequalling or commonly a little shorter than the calyx, strigillose, ciliate; calyx 3–4 mm. long, strigose-hirsute, lobes acuminate-subulate; corolla-tube approximately as long as the calyx, the throat pubescent without; corolla-limb 5–8 mm. broad; nutlets 2 mm. long, raised-reticulate on the upper half, faintly striate below, commissural faces reaching the apex of the nutlet, muricate or muriculately scabrous.

Distribution: Alabama to Texas.

Specimens examined:

ALABAMA: Navy Cove, Aug. 1889, *Mohr* (US).

LOUISIANA: without data, *Hale* (G, MBG), *Drummond* (G); vicinity of Alexandria, 9 June 1899, *Ball 605* (MBG, US); Chopin, 6 May 1915, *E. J. Palmer 7556* (MBG); St. Martinville, 30 May 1893, *Langlois* (MBG, US); Pointe a la Hache, 25 June 1884, *Langlois 123* (US); New Orleans, 1832, *Drummond 253 bis* (K TYPE of *V. strigosa*); near Schriever, 8 June 1917, *Munz 1607* (P); Cameron, 4 July 1903, *Tracy 8708* (F, G, MBG, NY, US).

ARKANSAS: near Homan, 10 June 1898, *Eggert* (MBG); Texarkana, Aug. 1881, *Letterman* (MBG, US).

TEXAS: Gladewater, 18 June 1901, *Reverchon 2532* (MBG, NY); near Longview, 7 June 1899, *Eggert* (MBG); Corsicana, 3 Oct. 1900, *Reverchon 2118* (MBG, US); Huntsville, 1920, *Warner 43* (US); sandy land, Brazos Co., 1899, *Ness* (G); Brazos, July 1899, *Lindheimer* (MBG); dry banks of Brazos River, 23 June 1917, *Munz 1470* (P); College Station, 24 July 1899, *Reverchon* (MBG); black land prairie, Montgomery Co., 18–21 July 1900, *Dixon 473* (F, G, NY); Burton, 26 May 1872, *Hall 434* (F, G, MBG, NY, P, US); Austin, 12 July 1920, *Tharp 667, 668* (US); Austin, Aug. 1921, *Schulz 679, 701* (US); San Marcos and vicinity, 1898, *Stanfield* (NY); Industry, 1844, *Lindheimer 145* (MBG); Cypress City, May 1877, *J. Ball* (MBG); near Houston, April 1842, *Lindheimer 154* (G, MBG); swamps, Houston, Aug. 1904, *Kuntze 23811* (NY); Lotus, about 16 km. west of Houston, 8 Aug. 1921, *Ferris & Duncan 3268* (MBG); Strand, Jefferson Co., 9 April 1924, *Tharp 3166* (MBG); Galveston, 6 June 1920, *Fisher 212* (US); Columbia, 5 Oct. 1900, *Bush 1275* (MBG); Columbia, 23 Sept. 1901, *Bush 899* (MBG); Hallettsville, 9 Aug. 1912, *Fisher 122* (US); Ottine, 30 Aug. 1926, *Bogusch 1235* in part (P); Sequin, 17 June 1903, *Groth 187* (F, G, NY, US); Cave Lake, Jackson Co., 30 June 1915, *Drushel 2842* (MBG).

This species is easily distinguished by its erect habit, coarse pubescence, elongated open spike, and sessile commonly trifid leaves. It has often been confused with *V. canescens* var. *Roemeriana*, but the latter is a smaller and more compact plant.

25. V. plicata Greene, Pittonia 5: 135. 1903.

Coarse herb with stems decumbent to ascending, branched, hirtellous; lower leaf-blades elliptic-ovate, narrowed into a margined petiole of approximately the same length, 1–3(–4) cm. long, broadly obtuse, plicate, coarsely incised-dentate, often

3-lobed, more or less canescent, rugose and somewhat appressed-hirsute above, hirsute beneath and prominently marked (particularly near the margin) with whitish veins; upper leaves similar but smaller, often appearing spathulate; spikes terminal on stems and branches, ordinarily not compact; bracts ovate-lanceolate, usually exceeding the calyx, at times barely equalling it, acute, hirsute, midrib often noticeable; calyx 3.5–4 mm. long, more or less glandular-hirsute, lobes very obtuse or subtruncate, terminating abruptly in subulate teeth; corolla-tube scarcely longer than the calyx; corolla-limb 4–6 mm. broad, anterior lobe retuse; nutlets cylindric-trigonous, 2–2.5 mm. long, shallowly scrobiculate above, changing to indefinitely striate toward the base; commissural faces finely muricate-scabrous to practically smooth, not reaching the tip of the nutlet.

Distribution: Texas, New Mexico, Arizona, and northern Mexico.

Specimens examined:

Texas: without data, *Berlandier 2506* in part, *644* (MBG); without locality, Sept. 1881, *Havard* (US); southwestern Texas, *Reverchon 118* (G); western Texas, 1851–2, *Wright 1496* (G, MBG, NY); sandy roadside, Chillicothe, 28 Sept.–3 Oct. 1906, *Ball 1171* (US); sands, Estelline, 25 May 1904, *Reverchon 4314* (MBG); sandy waste, Garza Co., 6 June 1925, *Ruth 1289* (US); Post, 22 May 1925, *Wooton* (US); Lubbock, 24 April 1930, *Demaree 7539* (US); moist open ground along creeks, Sweetwater, Nolan Co., 27 May 1918, *E. J. Palmer 13730* (MBG); north of Colorado, Mitchell Co., June 1900, *Eggert* (G, MBG); prairie north of Stanton, Martin Co., 13 June 1900, *Eggert* (MBG); rocky and sandy soils, Comanche, 8 Aug. 1877, *Reverchon 834* in part (MBG); near Comanche, 10 May 1900, *Eggert* (G, MBG); rocky prairies, Brown Co., 10 Aug. 1877, *Reverchon 737* in part (MBG); Brown Co., April 1882, *Reverchon 737* (US); San Angelo, 19 May 1903, *Reverchon 1953* (MBG); Barstow, 14 April 1902, *Tracy & Earle 30* (F, G, MBG, NY), type collection; Barstow, 15 April–3 May 1902, *Tracy & Earle 41* (NY); Oxona, 13 April 1930, *Jones 26221* (P); Davis Mountains, 5 Aug. 1918, *Young* (P); cliffs back of Fort Davis, Davis Mountains, 9–12 July 1921, *Ferris & Duncan 2726* (MBG, NY, P); about 5 km. east of Study Butte, Brewster Co., 30 June 1931, *Moore & Steyermark 3299* (MBG); Alpine, 7 June 1926, *E. J. Palmer 30523* (MBG); near Boquillas, 17 April 1919, *Hanson 619* (MBG, US); Austin, 12 May 1872, *Hall 429* (F, G, NY); gravel bars of Blanco River, Blanco, 5 April 1918, *E. J. Palmer 13282* (MBG); near Feodora, Terrell Co., 26 April 1928, *E. J. Palmer 33537* (MBG, NY); Devils River, Valverde Co., May 1913, *Orcutt 6235* (MBG); Corpus Christi Bay, Dec. 1879, *Palmer 2038* (G); Laredo, Aug. 1879, *Palmer 2040* (G); Laredo, *Berlandier 1485 (= 225)* in part (G); Laredo, 21 March 1903, *Reverchon 3904* (G, MBG, US); Laredo, 1913, *Orcutt 5555, 5717* (MBG); near Pharr, Hidalgo Co., 6 April 1931, *McKelvey 1756* (G).

New Mexico: plains, Carrizoza, 8–19 May 1902, *Earle 606* (NY); in valley near Gray, 26 July 1900, *Earle 427* (NY, US); neighborhood of San Miguel, 12 Aug. 1847, *Fendler 594* (G, MBG).

Arizona: desert prairie, north of Tucson, 24 April 1913, *Greenman & Greenman 28*

(MBG); Tucson, 2 May 1892, *Toumey 306* (US); slopes west of Tucson, 30 Dec. 1919, *Bartram 256* (ANSP); Cienega, near Pantano, 14 June 1881, *Pringle* (F, G, MBG); valley near Camp Lowell, 8 June 1882, *Pringle* (ANSP, F, NY); near Fort Lowell, 15 Sept. 1900, *Griffiths 1595* (NY).

Mexico:

Chihuahua: Colonia Juarez, Sierra Madre Mountains, 11 Sept. 1903, *Jones* (P).
Coahuila: Sierra Mojada Mountains, 19 April 1892, *Jones 372* (P, US).

In habit *V. plicata* is somewhat similar to *V. neomexicana*, but in inflorescence it strongly resembles *V. canescens* var. *Roemeriana*. Its distinctive character is foliar and is most easily seen in the basal and the lower stem-leaves. The leaf is obviously petioled, often 3-lobed, and very shallowly incised-dentate; moreover, the veins beneath are whitish and particularly prominent near the margin owing to the plication of the leaf and the apparent broadening of the veins in this region.

26. **V. neomexicana** (Gray) Small, Fl. Southeast. U. S. ed. 1, 1010. 1903, and ed. 2, 1913.

V. canescens var. *neomexicana* Gray, Syn. Fl. N. Am. 2^1: 337. 1878.

V. officinalis var. *hirsuta* Torr. Bot. Mex. Bound. 2: 128. 1859.

Plant slender; stems upright, branched, hirsute; leaves 1–5 cm. long, pinnately cleft or almost parted, segments incised or coarsely toothed, rugose, somewhat scabrous and finely pustulate above, the veins more or less prominent beneath, hirsute on both surfaces; spikes solitary or tending to be panicled, usually short-peduncled, hirsute; bracts lanceolate-acuminate, commonly not longer than the calyx; calyx about 3 mm. long, hirsute-pubescent and very slightly glandular, teeth short and subulate; corolla-tube scarcely longer than the calyx; corolla-limb approximately 4 mm. broad; nutlets trigonous with convex back, 2 mm. long, very shallowly reticulate-scrobiculate on the upper half, longitudinally striate below; commissural faces extending to the tip of the nutlets.

Distribution: Texas and New Mexico.

Specimens examined:

Texas: Fort Davis, 13 Sept. 1918, *Young 1703* (US).

New Mexico: White Mountains, Lincoln Co., 12 Aug. 1897, *Wooton 646* (NY); Ruidoso Creek, Lincoln Co., 3 July 1895, *Wooton* (NY, US); Kingston, Sierra Co., 6 July 1904, *Metcalfe 955* (US); borders of thickets, near Coppermines, 1851, *Wright 1497* (G type, MBG, NY, US); Pinos Altos Mountains, 1880, *Greene* (F, MBG);

bottom of Tierra Blanca Canyon, Gila Forest, 18 Aug. 1916, *Chapline 609* (NY); G. O. S. Ranch, vicinity of Silver City, 27 Aug.–12 Sept. 1911, *Holzinger* (US); Mogollon Mountains, on or near West Fork of Gila River, Socorro Co., 28 Aug. 1903, *Metcalfe 612* (G, MBG, NY, P, US).

The collections of *Young 1703*, *Wooton 646*, and *Wooton* (collection of July 3, 1895) are by no means typical of the species, but perhaps are better placed here than elsewhere. This species appears to be very closely related to *V. canescens* and *V. gracilis*. It differs from both, however, in the upright habit and the nutlets. In both *V. canescens* and *V. gracilis* the commissural face does not extend to the tip of the nutlet and the striae on the dorsal surface are less conspicuous.

26a. Var. xylopoda Perry,[20] n. var.

Stem somewhat coarser; pubescence shorter, denser and more glandular; calyx 4 mm. long, glandular-hirsute, teeth acuminate; corolla-limb 6–10 mm. broad.

Distribution: Arizona, California, and northern Mexico.

Specimens examined:

ARIZONA: Clarkdale, 17 Sept. 1921, *W. W. Jones 344*, *346* (G); Rio Verde, 8 Sept. 1865, *Coues & Palmer 571* (MBG); Skull Valley, 28 April 1903, *Jones* (MBG, P, US); near Oracle, 20 April 1930, *Harrison & Kearney 6689* (NY, P); Chiricahua Mountains, Cochise Co., 1 May 1894, *W. W. Price* (P); Paradise, Chiricahua Mountains, 16 Sept. 1907, *Blumer 2170* (F, US); Chiricahua Mine, 21 Oct. 1907, *Blumer 1804* (F, G, MBG, NY, US); Warren, Cochise Co., 20 May 1915, *Carlson* (US); Bisbee, 3 Oct. 1892, *Mearns 1013* (US); near Fort Huachuca, 1882, *Lemmon 2857* (G); Fort Huachuca, Aug. 1892, *Wilcox* (NY); Huachuca Mountains, 3 Sept. 1903, *Jones* (P); Ash Canyon, Huachuca Mountains, 6 Aug. 1909, *Goodding 334* (G, NY); Huachuca Mountains, 3 Sept. 1928, *Harrison & Kearney 5796* (US); Santa Catalina Mountains, 27 July 1917, *Munz 1149* (P); Sabino Canyon, Santa Catalina Mountains, 21 April 1922, *Hanson A1130* (MBG TYPE); about 13 km. south of Vail, 31 Aug. 1903, *Jones* (P); foothills of the Santa Rita Mountains, 11 May 1884, *Pringle* (ANSP, F, G, US); Santa Rita Forest Reserve, 8–13 Sept. 1902, *Griffiths 3431* (US); Santa Rita Range Reserve, 12 May 1912, *Wooton* (US); slopes about Calabasas, 21 April 1908, *Tidestrom 872* (US); Baboquivari Mountains, 28 March 1927, *Peebles, Harrison & Kearney 3790* (US); Baboquivari Mountains, 26 Sept. 1927, *Harrison 4778* (US); Baboquivari Mountains, 12 April 1928, *Gilman 1120* (P).

CALIFORNIA: without locality, 1876, *Palmer* (G), *339½* (US).

MEXICO:

LOWER CALIFORNIA: Big Canyon of Tantillas Mountains, 10 Sept. 1875, *Palmer* (G), *312* (F, MBG).

---

[20] Var. **xylopoda** Perry, var. nov., typicam simulans sed indumentum brevius densiusque; calyce 4 mm. longo glanduloso-hirsuto; calycis dentibus acuminatis; corollae limbo 6–10 mm. lato.—Collected on rocky slopes, Sabino Canyon, Santa Catalina Mountains, Arizona, 21 April 1922, *Hanson A1130* (MBG), TYPE.

Sonora: Guadalupe Canyon, 27 Aug. 1893, *Merton 2042* (US); "Niggerhead Mountains, near monument no. 82," Aug. 1893, *Mearns 1887, 1918* (US); Fronteras, June 1851, *Thurber 446* (G, NY).

Chihuahua: Saint Eulalia Hills, 30 July 1885, *Wilkinson* (US); San Diego, 26 April 1891, *Hartman 608* (G); rocky hills, near Chihuahua, 16 April 1885, *Pringle 270* (ANSP, F, G, US); vicinity of Chihuahua, 8–27 April 1908, *Palmer 52* (F, G, MBG, NY, US); "between Sacramento and Chihuahua," 24 Aug. 1846, *Wislizenus 150* (MBG); in the Sierra Madre, 21 June–29 July 1899, *Nelson 6161* (G, US); near Colonia Garcia, 29 July 1899, *Townsend & Barber 192* (F, G, MBG, NY, P, US); between Colonia Garcia and Pratt's Ranch, below Pacheco, 22–24 Aug. 1899, *Nelson 6271* (G, US).

This variety differs from the species in the denser and more glandular pubescence and the larger corolla. The nutlets also are slightly longer, with the reticulations somewhat deeper than in the species, and the commissural faces hardly extend to the tip of the nutlets. The specimens *Nelson 6161*, *6271* and *Townsend & Barber 192* closely resemble the above variety in inflorescence, but are more like *V. neomexicana* in the long and somewhat sparsely hirsute indument on the lower part of the stem; *Pringle 270* and *Wilkinson* approach variety *hirtella.*

26b. Var. **hirtella** Perry,[21] n. var.

Plants densely canescent-hirtellous; leaves more or less shallowly incised; bracts usually broadly ovate-acuminate; corolla-limb about 8 mm. broad.

Distribution: Texas, New Mexico, and Coahuila, Mexico.

Specimens examined:

Texas: rocky places between Van Horn Wells and Muerte, 2 July 1852, *Parry, Bigelow, Wright & Schott* (NY, US); Sivermore Peak, Davis Mountains, 9–12 July 1921, *Ferris & Duncan 2607* (MBG, NY); sand bars of creeks, Davis Mountains, 11 July 1926, *E. J. Palmer 30791* (MBG); Valentine, 28 April 1930, *Jones 26224* in part (P); near Shafter, Presidio Co., 26 April 1931, *McKelvey 2046* (G); Pinto Canyon, near Ruidosa, 13 April 1919, *Hanson 645* (G, NY, US); Chisos Mountains, 12 Aug. 1915, *Young 112* (MBG); foothills of Chisos Mountains, 22 May 1928, *E. J. Palmer 34065* (MBG type, NY); gravelly mesa, north side of Chisos Mountains, 27 June 1931, *Moore & Steyermark 3277* (MBG).

New Mexico: Socorro Mountains, 11 July 1897, *Herrick 715* (US); low mountains west of San Antonio, 14 April 1908, *Wooton 3852* (US).

Mexico: Coahuila: Sierra de Parras, *Purpus 1094* (F, G, MBG, NY, P).

The pubescence of this variety is much finer and shorter than

[21] Var. hirtella Perry, var. nov., planta dense hirtello-canescens; foliis plus minusve breviter incisis; bracteis fere late ovato-acuminatis; corollae limbo circiter 8 mm. lato.—Collected on the foothills of the Chisos Mountains, Texas, 22 May 1928, *E. J. Palmer 34065* (MBG), type.

in the above. The leaves are not so deeply incised and often tend to be elongated. The leaves of *Purpus 1094* are so narrow and shallowly incised that it appears superficially like *V. perennis;* nevertheless, the character of the pubescence allies it with this variety.

27. **V. perennis** Wooton, Bull. Torr. Bot. Club **25**: 262. 1898.

Stems several from a woody base, divaricately ascending-erect, more or less strictly branched, glabrate or often finely glandular and slightly hispidulous with short stiff antrorse hairs; leaves predominantly linear, 1–4 cm. long, entire or pinnately few-lobed, erect-ascending, sparsely hispidulous, margins revolute; spikes terminal, pedunculate, slender-filiform, elongate; bracts ovate, 1.5–3 mm. long, acute, hispidulous, ciliate; calyx 4–5 mm. long, pubescence more abundant along the nerves, lobes subequal, short, acute; corolla-tube slightly longer than the calyx, pubescent; corolla-limb 5–7 mm. broad, lobes repand; fruit more or less remote; schizocarp 3 mm. long, strongly constricted along the lines of cleavage; nutlets subcylindric, reticulate-scrobiculate except at base; commissural faces smooth or slightly scabrous and not extending to the tip of the nutlet.

Distribution: Texas and New Mexico.

Specimens examined:

TEXAS: Glass Mountains, 25 Aug. 1925, *Tharp 3682* (US); Loyola, 5 Nov. 1902, *Seler* (G); Guadalupe Mountains, 1882, *Havard 197* (G); Guadalupe Mountains, 13 Aug. 1916, *Young* (MBG); rough grassy slopes, McKittrick Canyon, Guadalupe Mountains, 23 July 1931, *Moore & Steyermark 3611* (MBG); Guadalupe Mountains, 8 Aug. 1931, *Clarke 4250* (MBG).

NEW MEXICO: Guadalupe, Oct. 1881, *Havard* (US); Queen, Aug. 1909, *Wooton* (MBG, US); Queen, 12–20 Aug. 1924, *Standley 40686* (US); Otero Co., 17 Aug. 1899, *Standley* (US); White Mountains, Lincoln Co., 21 July 1897, *Wooton 187* (G, MBG, NY, P), TYPE collection; Ruidoso Creek, White Mountains, 5 Aug. 1901, *Wooton* (MBG); north of El Capitan Mountains, Lincoln Co., 31 Aug. 1900, *Earle 387* (MBG, NY, P, US); Capitan, 8–19 May 1902, *Earle 619* (NY); Gray, Lincoln Co., 6 June 1898, *Skehan 20* (F, G, MBG, NY, P, US); Berendo Creek, 13 May 1905, *Metcalfe 1568* (F, G, MBG, NY, US).

The relationship of this species is somewhat anomalous. The lobing of the leaves and the character of the nutlets seem to ally it with *V. canescens* and its relatives; whereas the pubescence and the predominance of practically entire linear-oblong leaves recall *V. simplex.* It could scarcely be confused with either,

since the character combination of an open spike, very narrow leaves, and sparsely short-strigillose hairs is not found elsewhere in the group under consideration.

28. **V. gracilis** Desf. Cat. Hort. Paris, ed. 3, 393. 1829.

V. remota Benth. Pl. Hartw. 21. 1839.

V. arizonica Gray, Proc. Am. Acad. **19**: 95. 1883.

Low diffusely branched herb; branches decumbent to ascending, more or less glandular, canescent, hirsute; leaves ovate, cuneate at base and narrowed into a margined petiole, 1–3 cm. long, incised-pinnatifid to pinnately cleft, segments oblong, subincised, acutish, midrib and veins impressed, sometimes glandular, hirsute particularly on the lower surface; spike terminal, slender, more or less sparsely flowered, sessile, the lowermost flowers often appearing in the axils of the upper leaves; bracts linear, attenuate, gradually reduced in length toward the tip of the spike, usually much longer than the calyx; calyx 3 mm. long, more or less glandular, hirtellous, subtruncate, teeth minute and subulate; corolla inconspicuous, the tube somewhat longer than the calyx, the limb about 2–3 mm. broad; nutlets 1.5–2 mm. long, finely scrobiculate from the apex practically to the base; commissural faces muricately scabrous.

Distribution: Arizona, Utah, and Mexico.

Specimens examined:

(Par. TYPE, MBG phot.). Described from specimen cultivated in the Botanical Garden of Paris.

ARIZONA: Gardiner's Spring, 25 June 1882, *Pringle* (ANSP, F, G, NY); Gulching Ground, Pine Canyon, Chiricahua Mountains, 5 July 1907, *Blumer 1612* (F, G, MBG, NY, US); San Pedro River, Mexican Boundary Line, 12 Oct. 1892, *Mearns 1116* (US); Tanner's Cañon, near Fort Huachuca, 1882, *Lemmon* (G); Fort Huachuca, 1890, *Patzky* (US); Fort Huachuca, *Wilcox* (NY, US), *29* (US).

UTAH: mesa east of Monticello, 25 July 1911, *Rydberg & Garrett 9201* (NY).

MEXICO:

CHIHUAHUA: waste places, Chihuahua, 26 May 1885, *Pringle 54* (G); near Chihuahua, 7 May 1887, *Pringle* (F, MBG); vicinity of Chihuahua, 1–21 May 1908, *Palmer 200* (US).

DURANGO: city of Durango and vicinity, April–Nov. 1896, *Palmer 135* (F, G, MBG, NY, US), *911* (US); city of Durango, 1 Aug. 1898, *Nelson 4593* (MBG, US); Otinapa, 25 July–5 Aug. 1906, *Palmer 456* (G, US).

AGUASCALIENTES: (Zacatecas according to the Kew specimen): *Hartweg 174* (G, K TYPE of *V. remota*, NY).

SAN LUIS POTOSI: region of San Luis Potosi, 1878, *Parry & Palmer 722* (G, MBG, US); valley of San Luis Potosi, 1876, *Schaffner 720* (ANSP, G, MBG).

QUERETARO: Queretaro, 2100 m. alt., July 1904, *Kuntze 23444* (NY).

HIDALGO: Nopala, 1 Aug. 1913, *Salazar* (US); bare hills above Pachuca, about 2500 m. alt., 23 July 1898, *Pringle 7590* (F, MBG, P); dry calcareous mesas, near Metepec Station, about 2500 m. alt., 22 June 1904, *Pringle 13159* (F, G, US).

MEXICO: vicinity of Mexico, ? *Berlandier 578* (MBG, US); valley of Mexico, Pedrigal, about 2200 m. alt., 1 Sept. 1896, *Pringle 6539* (ANSP, F, G, MBG, NY, US); Santa Fe, 26 June 1865–6, *Bourgeau 361* (G); near Tlalpam, 15 July 1901, *Rose & Hay 5488* (US); near Tlalpam, July 1905, *Rose, Painter & Rose 8495* (G, US); lava beds, Tizapan, about 2250 m. alt., 24 Aug. 1900, *Pringle 9135* (G, MBG, NY).

OAXACA: near Mitla, June 1888, *Seler 22* (G).

V. gracilis is probably a relative of *V. canescens* and *V. neomexicana.* It is easily recognized by its slender habit, usually long-attenuate bracts, tiny flowers, and essentially scrobiculate nutlets. The specimen from Utah is atypical, but for practical purposes seems better referred here.

29. **V. canescens** HBK. Nov. Gen. et Sp. 2: 274, *pl. 136.* 1818.

Low coarse herb; stems several and branched, decumbent to ascending, canescent, hirsute; leaves oblong-lanceolate, 1–5 cm. long, acute, remotely incised-dentate or subpinnatifid, contracted into a margined entire semiamplexicaul or petiolar base, rugose and hirtellous above, the trichomes often with minute bulbous bases, canescent-hirsute and somewhat conspicuously veined beneath, margins revolute; spikes sessile or short-peduncled, mostly solitary, loose-flowered or compact, glandular-hirsute; bracts lanceolate, acuminate, variable in length, often exceeding the calyx, hirsute, ciliate; calyx about 3 mm. long, subtruncate, with very short inconspicuous teeth; corolla-tube slightly longer than the calyx; corolla-limb 4–6 mm. broad, lobes retuse; nutlets subcylindrical, 2 mm. long, raised-reticulate above, longitudinally striate at least half way from base to apex; commissural faces muricate-scabrous, not reaching the tip of the nutlets.

Distribution: Nevada and Mexico.

Specimens examined:

NEVADA: Caliente, 9 May 1892, *Jones 554* (P).

MEXICO:

COAHUILA: Saltillo and vicinity, 15–30 April 1898, *Palmer 25* (F, G, MBG, NY, US); Saltillo, 1200 m. alt., 22 Aug. 1913, *Adole 22* [*Arsène 10626*] (F, G, MBG, NY, US); valley near Saltillo, 1848–49, *Gregg 99, 246* (MBG); canyon and elevated portion of Sierra Madre, south of Saltillo, 25 July–1 Aug. 1880, *Palmer 1047* (ANSP, G, US);

near Buenavista, 22 May 1847, *Gregg* (NY), *740* (MBG); near San Pablo, 29 April 1847, *Gregg* (NY), *545* (MBG).

Zacatecas: near Conception del Oro, 11–14 Aug. 1904, *Palmer 303* (F, G, MBG, NY, US); Zacatecas, 1800–2100 m. alt., Aug. 1903, *Purpus 467* (US).

Aguascalientes: stony places, Aguas Calientes, *Hartweg 177* (G, NY); near Aguas Calientes, 20 Aug. 1901, *Rose & Hay 6212* (NY, US); near Aguas Calientes, 9 Oct. 1903, *Rose & Painter 7741* (G, NY, US).

San Luis Potosi: Angostura, June 1911, *Purpus 5515* (F, G, NY, US); in sands around San Luis Potosi, 1876, *Schaffner 719* (ANSP, G); San Luis Potosi, 1878, *Rose, Painter & Rose 8971*, *9162* (US).

Puebla: Cerro Guadalupe, 20 June 1909, *Nicolas* (US); margin of Atoyac, 20 June 1910, *Nicolas* (US); barren hills about Esperanza, 2660 m. alt., 17 Aug. 1905, *Pittier 414* (US).

Vera Cruz: Orizaba, 1853, *Mueller 1215* (NY); Esperanza, 2400 m. alt., 14 Aug. 1891, *Seaton 322* (F, G, US).

Oaxaca: Cerro de Wochixtlan, 16 Oct. 1921, *Conzatti 4288* (US); dry calcareous hills, Las Sedas, 1800 m. alt., 11 Aug. 1894, *Pringle 4784* (ANSP, G, MBG, NY, US); Las Sedas, about 1900 m. alt., 27 June 1895, *L. C. Smith 412* (G); Las Sedas, 1950 m. alt., 30 Aug. 1921, *Conzatti 4194* (US).

This is a low foliose species closely related to *V. neomexicana* and *V. plicata*, but distinguished from them by the semiamplexicaul elongate leaves and rather characteristic compact habit. The specimens cited from Coahuila are excellent examples of phases intermediate between the species and the variety. The collection from Nevada seems somewhat out of range. Possibly it was carried in as a weed or escaped from cultivation.

29a. Var. **Roemeriana** (Scheele) Perry, new comb.

V. Roemeriana Scheele, Linnaea **21**: 755. 1848.

Plants more densely hirsute, sparsely (if at all) glandular; floral bracts broadly ovate at base, abruptly acuminate, concave at anthesis, later slightly recurved, for the most part overtopping the calyx; dorsal surface of the nutlets reticulate-scrobiculate approximately two-thirds of their length, striate toward the base, nutlets usually more slender than in the species.

Distribution: Texas and Mexico.

Specimens examined:

Texas: without locality, 1846, *Lindheimer 500* (G, MBG, US); without locality, 1885, *Reverchon 737* in part (MBG); Red River, Wichita Co., 10 April 1922, *Tharp 1361* (US); sandy soils, Brown Co., *Reverchon 1961* (G, NY); near Brownwood, Brown Co., 1 Nov. 1925, *E. J. Palmer 29535* (MBG); Tom Greene Co., 1879, *Tweedy* (NY); Dove Creek, Tom Greene Co., May 1880, *Tweedy 113*, *246* (US); San Angelo, 13 May 1903, *Reverchon 3903* (MBG); Legion Creek, Gillespie Co., *Jermy 182* (MBG); gravel bars of Blanco River, Blanco, 5 April 1918, *E. J. Palmer 13283* (MBG);

Austin, 16 May 1872, *Hall 430* (F, G, MBG, NY, P, US); Austin, 1 April 1918, *Young 112* (MBG); San Antonio to Austin, 18 April 1925, *Small & Wherry 11969* (NY); Dryden, 22 April 1930, *Jones 26226* (MBG, P); Langtry, Valverde Co., May 1913, *Orcutt 6111* (MBG); rocky hills at Devils River, 10 Sept. 1900, *Eggert* (MBG); Lacey's Ranch, Kerr Co., 1 June 1916, *E. J. Palmer 10002* (MBG); Kerrville, 7–14 May 1894, *Heller 1732* (G, MBG, NY, US); San Marcos, 6 Nov. 1897, *Trelease* (MBG); New Braunfels, April 1850, *Lindheimer 294* (MBG), *1074* (F, G, MBG, NY, US); Ozona, 30 April 1930, *Jones 26222* (P); Rock Springs, 17 April 1930, *Jones 26223* (P); Del Rio, 20 April 1930, *Jones 26225* (P); Fort Clark, Kinney Co., 27 Feb. 1893, *Mearns 1237* (US); Fort Clark, 10 May 1893, *Mearns 1456* (US); gravel and sand deposits along stream, Uvalde, 11 May 1918, *E. J. Palmer 13563* (MBG); dry rocky ground along small stream, Uvalde, 24 April 1928, *E. J. Palmer 33605* (MBG); near Uvalde, 30 April 1928, *E. J. Palmer 33646* (NY); 16 km. west of Uvalde, 8 June 1931, *Moore & Steyermark 3005* (MBG); near Verde Creek, near Hondo, San Antonio to Del Rio, 21 April 1925, *Small & Wherry 11980* (NY); San Antonio, April 1911, *Clemens & Clemens 974* (MBG, P), *971*, *972*, *973* (P); San Antonio, 16 March 1916, *E. J. Palmer 9183* (MBG); on limestone hill, near Bracken, 27 June 1903, *Groth 16* (F, G, NY); in fields near Rio Frio, July 1829, *Berlandier 2054*, *644* in part (G); El Jardin, 10 March 1924, *Runyon 629* (US); woods near Colorado River, near Wharton, 12 April 1925, *Small & Wherry 11826* (NY); stony hills near Goliad, 9 April 1900, *Eggert* (G, MBG); near Mathis, San Patricio Co., 5 April 1931, *McKelvey 1710* (G); west San Diego, 31 July 1931, *Clark 4041* (MBG).

MEXICO:

NUEVO LEON: Walnut Grove, 27 May 1847, *Gregg 791* (MBG, NY); Monterey, 26 May 1847, *Wislizenus 325* (MBG); Monterey, 17–26 Feb. 1880, *Palmer 1044* (ANSP, G, US); Pico Chico, near Monterey, 19 March 1900, *Canby 194* (US); Monterey, 26 July 1926, *Fisher 235* (US).

TAMAULIPAS: vicinity of Victoria, 320 m. alt., 1 Feb.–9 April 1907, *Palmer 82* (F, G, MBG, NY as no. *8*, US); from Santander to Victoria, Nov. 1830, *Berlandier 827* (G, MBG, NY); Jaumave, 1931, *von Rozynski 13*, *17*, *135* (F).

Differing from the species chiefly in its coarser less glandular pubescence and the broadly ovate abruptly acuminate bracts. A few of the above-cited specimens show transitional phases, but, as a whole, are closer to the variety.

30. V. subuligera Greene, Pittonia 1: 156. 1888.

Stems probably several from a common base, procumbent, hirsute-pubescent; leaves ovate, gradually narrowed into a subpetiolar base, 1.5 to 4 cm. long, pinnately cleft, larger segments incised or sharply dentate, appressed-hirsute on both surfaces but especially beneath on the somewhat prominently reticulated veins; spikes short-petiolate, elongate, conspicuously bracted, in fruit interrupted; bracts lanceolate-subulate, twice as long as the calyx, ascending-spreading, reflexed in age, hirsute; fruiting calyx about 3 mm. long, pubescent, hirsute along the nerves,

lobes very short, strongly connivent over the schizocarp; corolla-tube scarcely longer than the calyx; nutlets subcylindric-trigonous, 2 mm. long, only faintly striate; commissure muriculate or smoothish, not reaching the top of the nutlet.

Distribution: Mexico.
Specimens examined:
MEXICO: DURANGO (?): "from the Sierra Madre, west of Durango," about 2400 m. alt., Sept. and Oct. 1881, *Forrer* (ANSP, F, G, NY, US), TYPE collection.

Although the general habit of this species is much like that of *V. bracteata*, the latter differs in having obtusish leaf-segments and sharply reticulate-striate nutlets with commissural faces fully as long as the nutlet.

31. **V. bracteata** Lag. & Rodr. in Anal. Cienc. Nat. **4**: 260. 1801.

V. bracteosa Michx. Fl. Bor.-Am. **2**: 13. 1803.

V. squarrosa Roth, Catalect. Bot. **3**: 3. 1806.

V. canescens Chapman, Fl. Southeast. U. S. 307. 1860.

V. bracteosa var. *brevibracteata* Gray, Syn. Fl. N. Am. 2^1: 336. 1878.

V. rudis Greene, Pittonia **4**: 152. 1900.

V. confinis Greene, Pittonia, *l. c.*

V. bracteosa var. *albiflora* Cockerell in Daniels, Fl. Boulder, Colo. 204. 1911.

V. imbricata Wooton & Standley, Contr. U. S. Nat. Herb. **16**: 166. 1913.

Zapania bracteosa Poir. in Lam. Encyc. **8**: 843. 1808.

Stems usually several from a common base, diffusely branched, decumbent or ascending, rarely erect, coarsely hirsute; leaves 1–4(–6) cm. long, pinnately incised or usually 3-lobed (lateral lobes narrow and divaricate, middle lobe large, cuneate-obovate, incisely toothed or cleft), narrowed into a short margined petiole, hirsute on both surfaces, midrib and veins slightly prominent beneath; spikes terminal, sessile, comparatively thick, conspicuously bracted; bracts much longer than the calyx, spreading-ascending, recurved in age, coarsely hirsute, the lowermost often incised and leaf-like, the upper linear-lanceolate, acute-acuminate, entire; calyx 3–4 mm. long, hirsute particularly along the nerves,

lobes very short, connivent over the schizocarp; corolla-tube protruding slightly beyond the calyx, very finely pubescent outside the throat; corolla-limb 2.5–3 mm. broad; nutlets trigonous, approximately 2 mm. long, sharply raised-reticulate above, striate below; commissural faces reaching to the distal end of the nutlet, muricately scabrous.

Distribution: waste places, Maine to Florida, west to California, and northern Mexico.

Specimens examined:

(Herb. Bot. Gard. Madrid TYPE, MBG phot.). Described from specimen cultivated in the Botanical Garden of Madrid.

ONTARIO: Point Edward, Lake Huron, 19 July 1901, *Macoun* (NY).

MAINE: Cumberland, 12 July 1902, *Chamberlain 418* (G).

MASSACHUSETTS: Dedham, 4 Aug. 1900, *Rich* (G); Worcester, 27 June 1904, *Dewhurst* (G).

CONNECTICUT: Winsted, Winchester, 5 Sept. 1909, *Fernald* (G); Bridgeport, 4 Sept. 1908, *Eames 8137* (G).

NEW YORK: Montauk Point, 23 July 1895, *von Schrenk* (MBG).

NEW JERSEY: Weehawken, Aug. 1894, *Van Sickle* (US); Kaighn's Point, Camden, 20 July 1866, *Parker* (G, MBG).

PENNSYLVANIA: "Cementon," valley of Lehigh River, 20 Aug. 1923, *Churchill* (G); Lancaster, 29 Aug. 1900, *Heller* (US).

NORTH CAROLINA: mountains of North Carolina, June 1872, *Leroy & Ruger* (NY); Statesville, June 1872, *Ruger* (US).

GEORGIA: Cartersville, *Ravenel* (NY); Thompsons Mills and vicinity, Gwinnett Co., 14 May 1908, *Allard 207* (MBG, US); Stone Mountain, 24 May 1897, *Eggert* (MBG); Ocmulgee River, swamp below Macon Island, 8–9 July 1895, *Small* (NY); Smithville, 18 Aug. 1885, *J. D. Smith* (MBG).

FLORIDA: without data, *Buckley* (MBG), *Chapman* (MBG); Apalachicola, 5 Aug. 1889, *Biltmore Herbarium 1082b* (NY, US).

ALABAMA: roads and uncultivated fields, Sept. 1843, *Rugel* (MBG); Stevenson, 5 Sept. 1877, *Ward* (US); Valley Head, July 1898, *Ruth 495* (NY), *518* (MBG); Wilcox Co., 18 May 1840, *Buckley* (NY); sandy ground, near Atalla, Etowah Co., 9 July 1898, *Eggert* (MBG, NY); Auburn, 13 May 1898, *Earle & Baker* (P, US); Mobile, 22 May 1884, *Mohr* (US).

LOUISIANA: vicinity of Alexandria, 5 June 1899, *Ball 553* (G, MBG, NY, US).

OHIO: Sandusky, 14 Aug. 1920, *Moseley* (G).

MICHIGAN: Vincent Lake, Cheboygan Co., 15 Aug. 1917, *Ehlers 627* (G); Manistee, 8 Aug. 1882, *Morong* (G).

INDIANA: roadside east of Bass Lake, Steuben Co., 25 July 1906, *Deam 1272* (MBG, NY, US); Michigan City, 6 July 1903, *Mell & Knopf* (MBG).

KENTUCKY: without data, *Rafinesque* (G); southern Louisville, 19 Aug. 1892, *Bergmann* (MBG).

TENNESSEE: Kingston Spring, 19 Aug. 1897, *Eggert* (MBG); Sherwood, 9 June 1897, *Eggert* (MBG); Memphis, 22 June 1851, *Fendler* (G).

WISCONSIN: Fort Howard, 22 July 1887, *Schuette* (G, US); Madison, 27 Aug. 1893, *Churchill* (G); near Mirror Lake, Sauk Co., 13 July 1903, *Eggert* (MBG).

ILLINOIS: Fountaindale, 1887, *Bebb* (G); Elgin, 27 Aug. 1912, *Sherff 1797* (MBG); Havana, 18 Aug. 1904, *Gleason* (G); Monticello, 17 June 1886, *Seymour & Waite* (G); Athens, *Hall* (US); East St. Louis, 11 June 1879, *Eggert* (P).

MINNESOTA: Princeton, July 1892, *Sheldon* (G, US); Collegeville, 29 July 1912, *Chandonnet* (MBG); hills between Minnehaha and Fort Snelling, 5 July 1888, *Schuette* (G); Fort Snelling, 26 July 1899, *Mearns 524* (US); Lake City, 25 July 1883, *Manning* (G).

IOWA: Lawler, 1890, *Rolfs* (G); Fayette Co., 30 July 1894, *Fink* (US); Black Hawk Co., 15 July 1929, *Burk 542a* (MBG); Ames, 5 Aug. 1896, *Ball* (G, MBG, NY, US); Ames, Aug. 1904, *Fawcett 12* (G, MBG, NY, US); Council Bluffs, *Vasey* (G).

MISSOURI: Hannibal, *Davis 2691, 3587, 9039* (MBG); Eolia, 26 May 1914, *Davis 2414* (MBG); St. Louis, Aug.–Sept. 1838, *Riehl 9* (MBG); St. Louis, Sept. 1841, *Engelmann* (G, US); Jefferson Ave., St. Louis, 2 July 1875, *Eggert* (MBG); Kimmswick, 15 July 1885, *F. Wislizenus 284* (MBG); Williamsville, Wayne Co., 27 June 1914, *E. J. Palmer 6106* (MBG); Poplar Bluff, 12 July 1930, *Kellogg 15276* (MBG); Sibley, 30 June 1906, *Bush 4010* (G, MBG); Courtney, *Bush 2109, 8537* (MBG); bluffs of Pomme de Terre River, Polk Co., 29 July 1891, *Trelease 715* (MBG); vicinity of Gates, 26 Aug. 1912, *Standley 9362* (US); Joplin, Jasper Co., 10 July 1897, *Trelease 494* (MBG); Webb City, 1 July 1903, *E. J. Palmer 454* (MBG); Swan, 28 Sept. 1899, *Bush 601* (MBG).

ARKANSAS: Monette, 14 June 1927, *Demaree 3353* (MBG); Jonesboro, 15 June 1927, *Demaree 3371* (G, MBG); Batesville, 1 Sept. 1897, *Trelease* (MBG); Fayetteville, *Harvey 62* (MBG); Fort Smith, 1853–4, *Bigelow* (US); Fulton, 22 Sept. 1900, *Bush 1034* (MBG).

NORTH DAKOTA: Leeds, 10 Sept. 1896, *Lunell* (G, US); Fairmount, 22 July 1912, *Bergman 2370* (MBG); Mandan, 1915, *Sarvis 122* (US); Dickinson, 14 Aug. 1908, *Holgate* (G, NY).

SOUTH DAKOTA: Swan Creek, 20 July 1911, *Visher 3359* (MBG); White River Valley, 8 July 1911, *Visher 2028* (NY); Deadwood, 23 July 1913, *Carr 179* (G, MBG, US); Lead City, 7 July 1892, *Rydberg 934* (NY, US); Black Hills, near Fort Meade, 19 June 1887, *Forwood 298* (US).

NEBRASKA: "very common on sandy banks of Yellowstone River," 1853–4, *Hayden 10* (MBG); St. James, 24 June 1893, *Clements 2612* (G, US); Lincoln, 20 June 1888, *Webber* (US); near Dix, 28 Aug. 1926, *Heller 14303* (MBG).

KANSAS: prairie, Riley Co., 18 June 1895, *Norton 392* (G, MBG, NY, US); Kearney Co., 27 Aug. 1897, *Hitchcock 1129* (MBG); bottom lands of Arkansas River, south of Kendall, 15 June 1929, *Rydberg & Imler 1008* (MBG); Ulysses, 27 June 1893, *Thompson 42* (MBG, NY, US); vicinity of Richfield, 20 Sept. 1912, *Rose & Fitch 17106* (US).

OKLAHOMA: Sapulpa, 22 July 1894, *Bush 436* (MBG); near Page, 20 June 1914, *Blakeley 1462* (G); near Alva, 1913, *Stevens 680½, 2889* (G); Woods Co., 21 June 1899, *White 206* (MBG); vicinity of Fort Sill, 22 May 1916, *Clemens 11750a* (MBG); near Snyder, 23 June 1913, *Stevens 1192* (G, NY); near Camp, 11 May 1913, *Stevens 391* (MBG).

TEXAS: Dallas, *Reverchon 736, 2116* (MBG); Tarrant Co., *Ruth 109* (G, NY); Fort Worth, *Ruth 109* (US); Polytechnic, *Ruth 109* (MBG); Abilene, 22 May 1902, *Tracy 8001* (G, MBG, NY, US); west of Big Spring, Sept. 1881, *Havard* (US); Amarillo, 2 Sept. 1910, *Ball 1675* (US); banks of Red River, Randall Co., 13 Aug. 1900, *Eggert* (MBG); Canyon, 2 June 1918, *E. J. Palmer 13861* (MBG); Lubbock, 10 June 1917, *E. J. Palmer 12496a* (MBG); El Paso, 7 June 1917, *Clemens* (P); below

Doñana, *Parry, Bigelow, Wright & Schott* (US); valley of Rio Grande, 64–80 km. below El Paso, ? 1851, *Wright 567* (G), *1499* (G, MBG, NY); valley of Rio Grande, St. Elizani, May–Oct. 1849, *Wright 454* (G, US).

ALBERTA: Crow's Nest Pass, Aug. 1897, *Macoun 24268* (NY).

MONTANA: about 20 km. above Glendive, 17 July 1883, *Ward* (US); near Glendive, 19–21 Aug. 1884, *J. Ball* (G); Thompson's Falls, 27 Aug. 1892, *Sandberg, MacDougal & Heller 972* (G, P, US).

WYOMING: Yellowstone National Park, 1 Aug. 1902, *Mearns 2698* (US); Mammoth Hot Springs, 22 Oct. 1902, *Mearns 5009* (NY, US); Casper, 6 July 1901, *Goodding 207* (G, MBG, NY, P, US); Blue Grass Hills, 8 July 1894, *A. Nelson 320* (G, MBG, NY, US); Laramie Peak, 8 Aug. 1895, *A. Nelson 1652* (P); Laramie, 24 July 1900, *A. Nelson 7671* (G, MBG, NY, P, US).

COLORADO: Fort Collins, 12 July 1884, *Sheldon 38* (G); Denver, 10 Aug. 1910, *Eastwood 25* (G, MBG, US); Manitou, 12 Aug. 1901, *Clements 9* (G, MBG, NY, US); Cheyenne Canyon, Colorado Springs, 16 Aug. 1915, *Drushel 4887* (MBG); vicinity of La Junta, 26 Sept. 1913, *Rose & Fitch 17503* (MBG, US); Deer Run, 25 Aug. 1901, *Baker 920* (G, MBG, NY, P, US); Cimarron, 29 July 1901, *Baker 288* (G, MBG, NY, P); Arboles, 18 June 1899, *Baker 564* (F, G, MBG, P), TYPE collection of *V. rudis*.

NEW MEXICO: without locality, 1847, *Fendler 587* (ANSP, G, MBG, US), *592* (MBG); Raton, 21–22 June 1911, *Standley 6268* (US); Cimarron Canyon, 21–24 Aug. 1903, *Griffiths 5560* (MBG); Farmington, 8 Aug. 1904, *Wooton 2831* (US TYPE of *V. imbricata*); Las Vegas, 1927, *Arsène 18543, 18593, 18634, 18885, 18961, 18964* (all P); vicinity of Las Vegas, 1926, *Arsène 18399* (ANSP), *18407* (MBG); near Pecos, San Miguel Co., 20 Aug. 1908, *Standley 5136* (MBG, NY, US); mouth of Indian Creek, Pecos River National Forest, 25 July 1908, *Standley 4549* (G, MBG, NY, US); Upper Rio Tesuque, 24 July 1908, *Standley 4458* (MBG, US); Santa Fe, 20 July 1926, *Arsène & Benedict 15734* (MBG); vicinity of Bernalillo, 11 July 1926, *Arsène & Benedict 16790* (ANSP); Sandia Mountains, 19 Aug. 1926, *Arsène & Benedict 16600* (MBG); Sandia Mountains, July–Aug. 1914, *Ellis 221* (MBG, US); Capelin Canyon, 14 Aug. 1914, *Ellis 221* (NY); near Albuquerque, 20 June 1926, *E. J. Palmer 31117* (MBG); Roswell, 24 Aug. 1900, *Earle 351* (MBG, P, US); Queen, 2 Aug. 1909, *Wooton* (MBG, US); near Fort Craig, 1 Aug. 1880, *Rusby 336* (MBG, NY); Organ Mountains, Dona Ana Co., 30 Aug. 1897, *Wooton 409* (G, MBG, NY, US), TYPE collection of *V. confinis;* Mesilla Valley, Dona Ana Co., 6 Aug. 1907, *Wooton & Standley 3330* (F, MBG); Kingston, 18 June 1904, *Metcalfe 1008* (G, MBG, NY, P, US); Berendo Creek, Sierra Co., 20 May 1904, *Metcalfe 897* (MBG); Gila River bottom, near Cliff, Grant Co., 13 June 1903, *Metcalfe 137* (G, MBG, NY, P, US).

ARIZONA: Tuba Oasis, 15–31 July 1920, *Clute 93* (G, MBG, NY, US); vicinity of Flagstaff, 13 July 1898, *MacDougal 286* (ANSP, G, NY, US); Flagstaff, 13 Aug. 1922, *Hanson A.147* (MBG); near Prescott, 26 July 1927, *Peebles, Harrison & Kearney 4243* (US); 16 km. west of McNary, 23 June 1930, *Goodman & Hitchcock 1317* (MBG, NY).

IDAHO: valley of Clearwater River, Nez Perces Co., 30 May 1892, *Sandberg, MacDougal & Heller 264* (G, MBG, NY, P, US); Falk's Store, Canyon Co., 7 July 1910, *Macbride 200* (MBG, US); alkaline flats, sink of Big Lost River, 16 Aug. 1895, *Henderson 4070* (US); near St. Anthony, 4 July 1901, *Merrill & Wilcox 776* (G, NY, US); Boise, July 1892, *Mulford* (G, MBG); Boise, 1911, *J. A. Clark 55* (G, MBG, P, US), *279* (G, MBG, NY, P, US).

UTAH: Oquirrh Mountains, Salt Lake City, 9–16 July 1902, *Pammel & Blackwood 3589* (G, MBG); Salt Lake City, June 1869, *Watson 823* (G, NY, US); Gunnison, 25

June 1875, *Ward 256* (G, US); Greenriver, 22 June 1894, *Jones 5478* (MBG, NY, P, US); along Bullion Creek, above Marysvale, 21 July 1905, *Rydberg & Carlton 7043* (G, NY, US); Milford, 4 June 1902, *Goodding 1022* (MBG).

Nevada: Winnemucca, 1 Sept. 1897, *Hillman* (P); saline flats, Las Vegas, 6 May 1905, *Goodding 2312* (G, MBG, NY); Colorado River bottoms, 24 km. east of Searchlight, 6 June 1915, *Parish 10288* (G, MBG).

British Columbia: Kamloops, 13 June 1889, *Macoun* (NY, US).

Washington: without locality, 1889, *Vasey 468* (G, NY, US); Cascade Mountains to Fort Colville, about lat. 49°, 1860, *Lyall* (G); Oroville, 26 June 1911, *Jones* (P); Meyers Falls, 21 Aug. 1902, *Kreager 474* (G, NY, US); near Egbert Spring, Douglas Co., 1 July 1893, *Sandberg & Leiberg 340* (G, MBG, NY, US); Sentinel Bluffs, 15 July 1903, *Cotton 1363* (G, US); Pullman, 21 July 1896, *Elmer 324* (MBG, NY); Wawawai, June 1896, *Elmer* (P); near river, Prosser, 10 July 1902, *Cotton 621* (G, MBG, US).

Oregon: without locality, 1871, *Hall 393* (G, MBG, NY); margin of shallow lake, Eastern Oregon, 25 June 1898, *Cusick 1967* (G, MBG); Snake River at mouth of Cache Creek, Wallowa Co., 28 May 1897, *Sheldon 8202* (MBG, NY); about 5 km. above mouth of Clark's Creek, 9 Sept. 1897, *Sheldon 8856* (MBG, NY, US); Pilot Rock, 2 Sept. 1896, *Brown 58* (MBG, US); Pilot Rock, July 1902, *Griffiths & Hunter 18* (NY, US); Butter Creek, Umatilla Co., 14 Sept. 1894, *Leiberg 902* (G, MBG, NY, US); about 16 km. west of Boardman, 17 July 1928, *Thompson 4880* (G, MBG, US); between Mosier and Rowena, 28–30 July 1922, *Abrams 9487* (MBG, P); The Dalles, on the Columbia, 2 Aug. 1880, *Englemann* (MBG).

California: near Monterey, *Bolander 426* (G); Jolon, 1880, *Vasey 512* (US); between Tulare and Tulare Lake, 25–30 Aug. 1892, *Palmer 2699* (US); near Lone Pine, Inyo Co., 14 June 1891, *Coville & Funston 953* (US); near San Bernardino, 3 June 1891, *Parish & Parish 2171* (NY, US); Soldiers Home, 20 June 1902, *Abrams 2574* (G, MBG, NY, P); near ponds, Laguna, *Munz 2207, 6349, 6598* (P); Laguna Canyon, 26 July 1916, *Crawford* (MBG, P); Blue Lake, Imperial Valley, 1 April 1903, *Abrams* (MBG, NY).

Mexico:

Lower California: Tia Juana, *Orcutt* (F, US), *1228* (MBG); Ensenada, 31 Aug. 1886, *Orcutt 1549* (MBG); Mancadero, 31 Aug. 1889, *Orcutt 1546* (MBG).

Sonora: Alamo, 20 May 1925, *Kennedy 7032* (US).

Chihuahua: 80 km. south of Juarez, 1911, *Stearns 7* (F, US); Bolsom de Mapini, 13 April 1847, *Gregg 433* (MBG).

Coahuila: near San Juan, valley of Nazas, 11 May 1847, *Gregg 636* (MBG); valley of Nazas, near San Lorenzo, 11 May 1847, *Gregg 623* (MBG); El Toro, near Movano, July 1910, *Purpus 4524* in part (US); San Lorenzo de Laguna and vicinity, southwest of Parras, 1–10 May 1880, *Palmer 1048* (ANSP, G, US).

A readily recognized and widely distributed species varying greatly in habit and pubescence as well as in length and position of floral bracts. The typical form is a sprawling hirsute plant with laxly ascending branches and spreading bracts. In New Mexico it appears as a nearly erect herb (*V. imbricata* Woot. & Standl.) with shorter and ascending or appressed bracts (var. *brevibracteata* Gray). Some phases of this variation occur

throughout the northwest range of the species, but since these tendencies to vary are apparently lacking in correlation, they do not seem to be worthy of nomenclatorial attention.

32. **V. carnea** Medic. Bot. Beobacht. **1783**: 131. 1784.
V. caroliniana Michx. Fl. Bor.-Am. **2**: 14. 1803.
V. carolinensis Small, Fl. Southeast. U. S. ed. 1, 1009. 1903, and ed. 2, 1913.
Phryma caroliniensis Walt. Fl. Car. 166. 1788.
Styleurodon carolinianum Raf. Fl. Tellur. **2**: 104. 1836.

Cinereous perennial; stems simple or sparingly branched above, ascending, puberulent; leaves spathulate to oblong or the upper oblong-hastate, sessile, shallowly serrate-dentate, scabrous above, less harsh and spreading-pubescent along the prominently reticulated veins of the lower surface; spikes terminal, pedunculate, chiefly solitary but occasionally in 3's, slender with crowded tips, more open in fruit; bracts lanceolate, about one-half shorter than the calyx, glandular-pubescent; calyx about 5 mm. long, glandular-pubescent, lobes acute, unequal; corolla-tube slightly longer than the calyx, pubescent without; corolla-limb about 5 mm. broad, segments somewhat truncate; anthers glandless; schizocarp 3 mm. long, not readily separating into 4 nutlets, longitudinally sulcate and commonly scrobiculate on the upper part.

Distribution: North Carolina to Florida, and west to Texas.

Specimens examined:

North Carolina: Pinehurst, 3 Sept. 1897, *Katzenstein* (G); open pine woods 3 km. south of James City, 11 July 1922, *Randolph* (G); Burgaw, Aug. 1878, *Hyams* (US), June 1879, *Hyams* (MBG).

South Carolina: Santee Canal, *Ravenel* (G); sandy open pine woods near Navy Yard, Charleston, 27 April 1912, *Robinson 26* (G); Summerville, June 1891, *Taylor* (US); Bluffton, 1881, *Mellichamp* (US); sand bank near Orangeburg, 8 May 1907, *House 3276* (NY); Aiken, July 1870, *Ravenel* (NY, US); sandy ground north of Graniteville, 23 May 1899, *Eggert* (MBG).

Georgia: sandy hills north of Augusta, 22 May 1899, *Eggert* (MBG); Augusta, 14 May 1900, *Cuthbert 268* (NY); Alexander, *Ellis* (P); Flint River at Albany, 24–28 May 1895, *Small* (F, NY).

Florida: without locality, *Buckley* (G, MBG); without locality, *Chapman* (NY); Lake City, 27 Feb. 1893, *Rolfs 191* (MBG); pine barren, Duval Co., 29 April 1902, *Fredholm 5136* (G, MBG, US); Oakwood, Duval Co., 1 June 1893, *Fredholm 110* (P); dry pine barrens, near Jacksonville, May, *Curtiss 1959* (G, MBG, NY, US), 8 May 1884, *Curtiss 4765* (G, NY, US), 29 April 1893, *Curtiss 4386* (MBG, US);

Hibernia, March 1869, *Canby* (G, NY, US); St. Augustine, 1877, *Reynolds* (NY); Gainesville, 11 May 1925, *O'Neill 986* (US); dry sandy woods, Irvine, 29 April 1930, *Moldenke 1091* (MBG, NY); Ocala, Marion Co., 2 April 1879, *J. D. Smith* (US); high pine land, vicinity of Eustis, 1–15 May 1894, *Nash 601* (G, MBG, US); pine lands at Lake Helen, 28 April 1906, *Deam 1799* (US); Fort Meade, March 1880, *J. D. Smith* (US); between Tallahassee and St. Marks, April 1843, *Rugel* (NY); sandy open ground near Tallahassee, 9 April 1929, *E. J. Palmer 35235* (G, MBG); Aspalaga, *Chapman* (MBG); dry pine barrens, near Apalachicola, 11 Aug. 1889, *Biltmore Herbarium 4761a* (G, NY, US).

ALABAMA: without locality, 1859, *Beaumont* (G); Auburn, Lee Co., 10 May 1896, *Earle & Underwood* (NY); Auburn, 10 Feb. 1897, *Earle & Baker* (NY); Pinewoods, *Buckley* (NY); woods, Spring Hill, 6 Aug. 1897, *Bush 312* (MBG, NY, US); Spring Hill, 25 June 1915, *Drushel* (MBG); open barrens, Spring Hill, June–July 1919, *Graves 621* (MBG, US); Mobile, May 1875, *Curtiss* (MBG); Mobile, June 1879, *Mohr* (US).

MISSISSIPPI: sandy soil, southern Mississippi, 1859, *Hilgard* (MBG); Ocean Springs, May 1892, *Seymour & Earle 118* (G, MBG); Ocean Springs, 8 May 1895, *Skehan* (MBG); Biloxi, 21 April 1898, *Tracy 4981* (G, MBG, NY, US); Long Beach, 6 Aug. 1891, *Joor* (MBG); Harrison Co., 19 April 1927, *Woodson & Anderson 1577* (MBG).

LOUISIANA: vicinity of Covington, 30 April 1920, *Arsène 12117* (US), 8 May 1920, *Arsène 11820* (US).

TEXAS: sandy open ground, Fletcher, Hardin Co., 25 April 1916, *E. J. Palmer 9559* (MBG).

One of the most distinct species of the genus in North America. It is readily recognized by the long slender graceful spike, the sessile elongate leaves, and the tardy splitting of the schizocarp. The last character is probably Walter's reason for placing this species in the genus *Phryma*.

SECTION 2. GLANDULARIA Schauer

2. GLANDULARIA Schauer in DC. Prodr. **11**: 550. 1847.

Sterile style-lobe adjacent to stigmatic surface and protruding well beyond it; ovary in later stages definitely but shallowly lobed at the distal end, with the style apparently inserted in a depression between the lobes; schizocarp constricted along the lines of cleavage; connective of the upper anthers chiefly appendaged. Herbaceous perennials with prostrate, decumbent, ascending, and sometimes erect stems. Flowers usually showy, at first fascicled or somewhat corymbose, later spicate. Calyx usually more than twice as long as the schizocarp and constricted or contorted beyond it. Species 33–51.

Key to the Species

A. Leaves tapering into a margined petiole or subsessile or sessile, at least not subauriculate and semiamplexicaul at the base.
  B. Nutlets with a very definite beak parallel to the axis of the schizocarp.. .... *33. V. quadrangulata*
  B. Nutlets with an indefinite beak or none.
    C. Nutlets suggesting a tendency toward a beak (a slight protrusion horizontal to the axis of the schizocarp); commissural face practically reaching the tip of the nutlet.................. *34. V. delticola*
    C. Nutlets without a beak; commissural face not reaching the tip of the nutlet.
      D. Nutlets subovoid, lateral surfaces ventricose and smooth, not at all similar to the dorsal surface..................... *39. V. tumidula*
      D. Nutlets subcylindrical, lateral surfaces not ventricose and usually scrobiculate, similar to the dorsal surface.
        E. Leaves shallowly lobed, incised or toothed.
          F. Corolla-tube slightly longer than the calyx.
            G. Calyx villous-hirsute, somewhat glandular .... *47a. V. Gooddingii* var. *nepetifolia*
            G. Calyx short-strigillose, not glandular........... *38. V. tampensis*
          F. Corolla-tube at least one-half longer than the calyx.
            H. Plants prostrate-decumbent; leaves varying from cuneate to orbicular-ovate; calyx-teeth short (1–1.5 mm. long)...... .... *37. V. maritima*
            H. Plants ascending, decumbent only at base; leaves ovate to elongate-ovate; calyx-teeth long (2–3 mm.).... *35. V. canadensis*
        E. Leaves 3-cleft, incised-pinnatifid or bipinnatifid.
          I. Corolla-tube protruding well beyond the calyx.
            J. Corolla-tube approximately twice as long as the calyx.
              K. Plants somewhat hirsute; both surfaces of the leaves similar in color; spikes elongating in age; calyx-teeth 2–3 mm. long.............................. *35. V. canadensis*
              K. Plants hispid-hirsute; lower surface of leaves lighter than the upper; spikes compact at maturity; calyx-teeth rarely surpassing 2 mm. in length.
                L. Plants prostrate-decumbent; spikes few-flowered..*36. V. elegans*
                L. Plants ascending, decumbent only at base; spikes many-flowered............... *36a. V. elegans* var. *asperata*
            J. Corolla-tube one-third to one-half longer than the calyx.
              M. Floral bracts equalling or exceeding the calyx; calyx not glandular, hispid-hirsute.
                N. Leaves bipinnatifid, ultimate segments linear-oblong.. .... *40. V. bipinnatifida*
                N. Leaves 3-cleft, with segments remotely incised or lobed, ultimate segments much broader than in the above. .... *40a. V. bipinnatifida* var. *latilobata*
              M. Floral bracts shorter than the calyx; calyx for the most part somewhat glandular, hispid-hirsute to villous-pubescent.

O. Leaves sessile, strigose-hispid.............*45. V. Andrieuxii*
O. Leaves subsessile to short-petiolate, hispidulous-hirsute to hirtellous.
P. Plants coarse; leaves usually 2.5–4 cm. long, hispidulous-hirsute; corolla-limb 6–12 mm. broad; nutlets 2.5–3 mm. long.
Q. Calyx-teeth long (2–3 mm.).
R. Plants usually tall (2–4 dm.); leaves bipinnatifid with ultimate segments lanceolate; calyx-teeth not especially conspicuous in mature fruit.
S. Calyx glandular................*41. V. ambrosifolia*
S. Calyx not glandular.*41a. V. ambrosifolia* f. *eglandulosa*
R. Plants usually low (1–2 dm.); leaves trifid with segments more or less incised; calyx-teeth conspicuously long in mature fruit ....
..................*43a. V. ciliata* var. *longidentata*
Q. Calyx-teeth short (usually less than 2 mm.).
T. Plants decumbent-ascending or prostrate, densely hirsute; calyx somewhat glandular, hispidulous-hirsute, scarcely viscid.
U. Plants with decumbent-ascending loose habit; leaf-margin slightly revolute.. ...*43. V. ciliata*
U. Plants with prostrate compact habit; leaf-margin strongly revolute..*43b. V. ciliata* var. *pubera*
T. Plants ascending-erect, more or less hirsute; calyx densely glandular-hirsute and somewhat viscid-pubescent...................*42. V. Wrightii*
P. Plants slender; leaves smaller, 1–2.5 cm. long, hirtellous; corolla-limb 5–6 mm. broad; nutlets 2 mm. long..........................*44. V. racemosa*
I. Corolla-tube slightly longer than the calyx.
V. Calyx-teeth acute-subulate, short (less than half as long as the calyx-tube).
W. Plants repent, slender; spikes few-flowered, scarcely protruding beyond the subtending leaves.
X. Corolla-limb 5–7 mm. broad. ....*46. V. teucriifolia*
X. Corolla-limb 3 mm. broad..*46a V. teucriifolia* var. *corollulata*
W. Plants decumbent-ascending, stouter; spikes many-flowered, subsessile or short-pedunculate.
Y. Plants more or less hirsute, decumbent; corolla inconspicuous, limb 3–5 mm. broad ....*48. V. pumila*
Y. Plants densely pilose-villous, ascending; corolla conspicuous, limb 8–9 mm. broad. ......*47. V. Gooddingii*
V. Calyx-teeth subulate-setaceous, elongate (approximately half as long as the calyx-tube).
Z. Plants decumbent-ascending, villous-pubescent; leaves ovate, trifid with the segments coarsely dentate.*49. V. setacea*
Z. Plants erect, sparsely hirsute; leaves narrow and elongate, bipinnatifid, with the segments linear..........*50. V. lilacina*
A. Leaves subauriculate and semiamplexicaul at the base............*51. V. amoena*

33. V. quadrangulata Heller, Contr. Herb. Franklin & Marshall College (Bot. Expl. S. Texas) **1**: 84, *pl. 6.* 1895.

V. pumila f. *albiflora* Standl. Field Mus. Publ. Bot. **4**: 256. 1929.

Helleranthus quadrangulatus Small, Fl. Southeast. U. S. ed. 1, 1011. 1903, and ed. 2, 1913.

Low plant more or less diffusely branched from the base; stems prostrate-ascending, rooting at the lower nodes, hirsute; leaves 1–3 cm. long, broadly ovate, with cuneate base contracted into a very short margined petiole, incised-pinnatifid or 3-cleft, with lobes incised, strigose-hirsute on both surfaces; spikes compact, sessile or nearly so, terminal; bracts somewhat shorter than the calyx, narrowly lanceolate, hirsute, ciliate; fruiting calyx 5(–6) mm. long, hirsute, particularly along the ribs, lobes short, subulate-tipped; corolla-tube slightly longer than the calyx, practically glabrous without; corolla-limb 2.5–3 mm. broad, lobes emarginate; anthers unappendaged; ovary surmounted by subhemispheric-angulate stylopodium; schizocarp constricted along the lines of cleavage; nutlets 4 mm. long, crowned with a smooth obtusish beak, shallowly reticulate-scrobiculate above, longitudinally striate and somewhat abruptly enlarged at base.

Distribution: Texas and northern Mexico.

Specimens examined:

Texas: sandy beach and open flats, Rio Bravo del Norte, *Schott* (NY); Devils River, Val Verde Co., 15 May 1913, *Orcutt* (MBG); creek between Del Rio and Comstock, 22 April 1925, *Small & Wherry 12010* (NY); "Brackett" (? Brackettville), 22 Aug. 1900, *Trelease 101* (MBG); Spofford Junction, 22 March 1900, *Canby 193* (US); Uvalde, 28 April 1928, *E. J. Palmer 33592* (G, MBG, NY); San Antonio, April 1922, *Schulz 767* (US); 24 km. south of San Antonio, 28 April 1921, *Schulz 475* (US); woods near Colorado River, near Wharton, 12 April 1925, *Small & Wherry 11824* (NY); railroad north of Moore Station, Frio Co., 5 April 1901, *Eggert* (MBG); sandy open ground, Pleasanton, 16 May 1916, *E. J. Palmer 1747* (MBG); El Jardin, 10 March 1924, *Runyon 628* (US); Eagle Pass, April 1883, *Havard* (US); Kennedy-Beeville, 15 March 1929, *Tharp 5538* (US); Kennedy-Portland, 17 March 1929, *Tharp 5610* (US); Corpus Christi Bay, Dec. 1879, *Palmer 1046* (G); Corpus Christi, 10 March 1894, *Heller 1388* (G, MBG, NY), type collection; San Diego, 1885–6, *Croft 78* (NY); Kingsville, 27 March 1920, *High 75* (MBG); between Laredo and Bejar, Feb. 1828, *Berlandier 1485=225* (G); Laredo, Feb. 1891, *Dodge 154* (US); sandy ground, Laredo, 6 April 1901, *Eggert* (G, MBG); Laredo, 21 March 1903, *Reverchon 3902* (G, MBG, NY, P, US); Laredo, 1913, *Orcutt 5542, 5730* (MBG); San Antonio, 1926, *Pagel 2208* (F); Guadalupe, 168 km. southwest of San Antonio,

Sept. 1879, *Palmer 2039* (G); chaparral near Harlingen, 6 April 1925, *Small & Wherry 11903* (NY); Brazos Santiago, 1889, *Nealley* (F, US).

Mexico: Tamaulipas: east of Matamoros, May 1836, *Berlandier 3018=1518* (MBG).

Verbena quadrangulata is an anomalous species often confused with *V. pumila* on account of the strong similarity in habit, but is perhaps more closely related to *V. delticola*, the only other known North American species with a tendency toward developing a nutlet with a beak. The style is enlarged at the base into a persistent subhemispherical body; hence, when the nutlets split apart they appear as if elongated at the apex into a beak-like appendage. Although the anthers are not glandular and the flowers not showy, the species seems to belong to the section *Glandularia*.

34. V. delticola Small,[22] n. sp.

Stems decumbent to ascending, branched, more or less hirsute; leaves ovate-deltoid, 3–7 cm. long, with truncate-cuneate base narrowed into a margined petiole, obtusish or acutish, coarsely serrate-dentate, often trilobed, usually thin, sparsely appressed-hirsute on both surfaces, trichomes above often with minute bulbous bases; spikes peduncled, fascicle-like in anthesis, becoming elongated in fruit; bracts linear-attenuate, shorter than or equalling the calyx; calyx 7–8 mm. long, sparsely glandular, hirsute, lobes slender, subulate, unequal; corolla-tube protruding well beyond the calyx, pubescent or glabrate without; corolla-limb probably 10 mm. broad, segments emarginate; nutlets 3 mm. long, subcylindrical, reticulate from the apex to the definitely broadened base; commissural face practically reaching the tip of the nutlet, muricately scabrous.

[22] **V. delticola** Small, spec. nov., herbacea verisimiliter perennis; caulibus decumbentibus vel ascendentibus ramosis plus minusve hirsutis; foliis ovato-deltoideis basi cuneata in petiolum alatum attenuatis 3–7 cm. longis obtusiusculis vel acutis grosse serrato-dentatis saepe trilobis utrinque sparse adpresso-hirsutis; spicis pedunculatis; bracteis lineari-attenuatis calyce brevioribus vel subaequantibus; calyce 7–8 mm. longo sparse glanduloso hirsuto; calycis dentibus subulatis inaequalibus; corollae tubo exserto extus pubescente vel glabrato; corollae limbo circiter 10 mm. lato segmentis emarginatis; coccis subcylindricis 3 mm. longis superne reticulatis.—Collected at Las Palmas Ranch, vicinity of Brownsville, Texas, 1–5 Aug. 1921 *Ferris & Duncan 3161* (NY), type.

Distribution: Texas and Mexico.

Specimens examined:

TEXAS: Edinburg, *Hooker 5999* (US); Samfordyce, 1927, *Molby 7224* (US); chaparral near Harlingen, 16 April 1925, *Small & Wherry 11901* (NY); Brazos Santiago, 1889, *Nealley 117, 118* (US); Reynoldsville, Cameron Co., 11 April 1905, *Lewton 141* (US); Las Palmas Ranch, vicinity of Brownsville, 1–5 Aug. 1921, *Ferris & Duncan 3161* (MBG, NY TYPE).

MEXICO:

NUEVO LEON: Rinçonada, 24 April 1847, *Gregg 752* (MBG); Guajuco, March 1880, *Palmer 1051* (G, US); Walnut Grove, near Monterey, 7 Feb. 1847, *Gregg 202* (MBG); river gravel, near Monterey, 11 July 1888, *Pringle 2228* (G); Sierra Madre, near Monterey, 25 Aug. 1903, *Pringle 11843* (G, US); Loma del Obispodo, Monterey, 1 Feb. 1907, *Safford 1221* (US); Monterey, Guadalupe, May 1911, *Arsène 6129* (G, MBG, NY, US); Monterey, 10–11 March 1923, *Tharp 1826* (US).

TAMAULIPAS: Victoria, 23 May 1898, *Nelson 4424* (G, US); vicinity of Victoria, 1 Feb.–9 April 1907, *Palmer 39* (F, G, MBG, NY, US); San Fernando to Jimeney, 26–27 Feb. 1902, *Nelson 6628 (? 6028)* (G, MBG, NY, US); vicinity of Tampico, 1–31 Jan. 1910, *Palmer 90* (F, G, MBG, NY, US).

SAN LUIS POTOSI: La Hoya, *Liebmann 11314* (US).

PUEBLA: near Metlaltoyuca, 31 Jan. 1918, *Goldman 42* (US).

VERA CRUZ: Wartenburg, near Tantoyuca, April 1858, *Ervendberg 236* (G); Colipa, March 1841, *Liebmann 11313* (US).

Superficially, this species bears a strong resemblance to *V. canadensis*, but usually the leaves are not so deeply incised. Its distinctive character is found in the nutlet. Commonly, in the section *Glandularia*, the schizocarp is shallowly lobed at the apex; hence, the style appears to be attached in a very definite depression and ordinarily the commissural face does not reach the tip of the nutlet. In *V. delticola*, however, the depression is indefinite, the commissural face practically reaches the tip, and the separate nutlets viewed from the lateral or ventral surface suggest a tendency toward developing a beak. In *Safford 1221* a small beak is present.

35. **V. canadensis** (L.) Britton, Mem. Torr. Bot. Club **5**: 276. 1894.

V. Aubletia Jacq. Hort. Vind. **2**: 82, *pl. 176.* 1772; Linn. f. Suppl. 86. 1781; Bot. Mag. *pl. 308.* 1795; Bot. Reg. *pl. 294.* 1818.

V. Oblaetia Retz. Svenska Vet. Akad. Nya Stockh. Handl. **34**: 143, *pl. 5.* 1773.

V. Obletia Medic. Act. Acad. Theod.-Palat. **3**: 194, *pl. 7.* 1775.

V. longiflora Lam. Tab. Encyc. **1**: 57. 1791.

V. rubra Salisb., Prodr. 71. 1796.

V. Lamberti Sims in Bot. Mag. *pl. 2200.* 1821.

V. Aubletia var. *Drummondi* Lindl. Bot. Reg. *pl. 1925.* 1837.

V. Lamberti var. *rosea* Sweet, Brit. Fl. Gard. II. **4**: 363. 1838.

V. Drummondii Hort. ex G. Don in Loud. Hort. Brit. Suppl. **2**: 680. 1839.

V. Drummondii (Lindl.) Baxt. ex Small, Fl. Southeast. U. S. ed. 1, 1011. 1903, and ed. 2, 1913.

V. canadensis var. *Lamberti* Thell. Fl. Advent. de Montpellier, 428. 1912.

Buchnera canadensis L. Mant. 88. 1767.

Billardiera explanata Moench, Method. 369. 1794.

Anonymos caroliniensis Walt. Fl. Carol. 164. 1788.

Glandularia caroliniensis J. F. Gmel. Syst. Veg. **2**^{2}: 920. 1791.

G. Aubletia Nutt. Trans. Am. Phil. Soc. **5**: 184. 1837.

Stems decumbent to ascending, rooting at the lower nodes, more or less branched, spreading-hirsute or glabrate; leaves ovate to elongate-ovate, 3–9 cm. long, 1.5–4 cm. broad, with truncate or cuneate base narrowed into a margined petiole, incised or incised-pinnatifid or 3-cleft, appressed-hirsute or glabrate on both surfaces; spikes pedunculate, fascicle-like in anthesis, becoming elongated in fruit; bracts shorter than (or occasionally as long as) the calyx, linear-attenuate, hirsute, usually ciliate; calyx glandular-hirsute, in fruit 10–13 mm. long, lobes very slender, subulate-setaceous, unequal, the posterior lobe much shorter; corolla-tube about twice as long as the calyx, glabrous without or finely pubescent or glandular; corolla-limb 11–15 mm. broad, segments emarginate; anther-glands not minute; schizocarp at maturity constricted along the lines of cleavage; nutlets 3(–3.5) mm. long, subcylindrical with slightly broadened base, reticulate-scrobiculate; commissural face muricate-scabrous.

Distribution: North Carolina to Florida, and west to Colorado and Texas.

Specimens examined:

North Carolina: roadsides, Kittrell, 11 April 1889, *Sturtevant* (MBG).

South Carolina: Abbeville District, *Hexamer & Maier* (G).

Georgia: by roads and margins of fields through lower Georgia and middle Florida, March 1843, *Rugel* (MBG).

Florida: Fort King, *Alden* (NY); St. Nicholas, Duval Co., July 1898, *Lighthipe 599* (NY); Mous Creek, St. John's Co., 15 April 1879, *J. D. Smith* (US); rich woods in Daytona, 30 March 1906, *Deam 1831* (US); Ocala, 4 April 1879, *J. D. Smith* (US).

ALABAMA: above Tuscaloosa, 8 May 1875, *E. A. Smith* (US); above Tuscaloosa, 11 April 1892, *Ward* (US).

LOUISIANA: without locality, *Hale* (G, US), *Short* (NY); Minden, 15 April 1901, *Trelease* (MBG); Winnfield, 13 April 1912, *Petersen* (NY); Natchitoches, 16 March 1915, *E. J. Palmer 7001* (MBG); Chopin, Natchitoches Parish, 23 March 1915, *E. J. Palmer 7071* (MBG); vicinity of Covington, 20 March 1920, *Arsène 11982* (US); Jacksonville, *Drummond* (G); Cameron, 4 July 1903, *Tracy 8707* (G, MBG, NY, US).

KENTUCKY: Shelbyville, *Flint* (G).

TENNESSEE: Cedar Glades, north of Lavergne, 4 May 1898, *Eggert* (MBG).

IOWA: Council Bluffs, *Vasey* (G).

MISSOURI: St. Louis, May 1833, *Engelmann 334* (MBG); St. Louis, 8 July 1910, *Sherff 333* (G); Windsor Springs, 30 May 1890, *Hitchcock* (MBG); St. Louis Co., 16 May 1879, *Eggert* (MBG, US); Allenton, 27 April 1887, *Eggert* (MBG); west of Kimmswick, 13 April 1918, *Drushel 3659* (MBG); Kimmswick, 30 April 1905, *Johnson* (MBG); Hillsboro, 24 May 1885, *F. Wislizenus 285* (MBG); Crystal City, 19 Aug. 1886, *Eggert* (MBG); sandy ground north of Crystal City, 6 May 1891, *Eggert* (MBG); Silica, 18 April 1896, *Eggert* (MBG); Shot Hill, near Selma, 30 May 1923, *Greenman 4231* (MBG); Victoria, 10 May 1890, *Hitchcock* (MBG); Old Mines, Washington Co., 19 Aug. 1928, *Kellogg 1958* (MBG); Blackwell, St. Francois Co., 18 April 1897, *Trelease 714* (MBG); Central, 28 Aug. 1898, *Trelease 1161* (MBG); banks of Pilot Knob Creek, 9 Sept. 1859, *Engelmann* (MBG); Pilot Knob, July 1867, *Engelmann* (MBG); Granite Mountain, Iron Co., 24 May 1918, *Greenman 4076* (MBG); Ironton, 4 May 1923, *Epling 6134* (MBG); Shepard Mountain, Iron Co., 26 May 1918, *Greenman 3870* (MBG); Shut In, Stout Creek, Iron Co., 28 May 1916, *Drushel 2762* (MBG); near Silvermine, Madison Co., 20 May 1927, *Greenman* (MBG); Mine La Motte, 19 May 1927, *Greenman* (MBG); Grandin, 5 May 1901, *Bush 318* (MBG); dry rocky banks, Shannon Co., 13 April 1889, *Bush 1168* (MBG); Jerome, 5 April 1914, *Kellogg* (MBG); Jackson Co., 28 March 1864, *Broadhead* (MBG); Jackson Co., 28 May 1893, *Bush 283* (G, MBG); Independence, 1 June 1895, *Tindall* (MBG); Dodson, 27 April 1904, *Bush 1933* (MBG); rocky woods, Vale, 13 April 1908, *Bush 4922* (MBG, US); barrens, Greenwood, 28 Oct. 1915, *Bush 2901* (G, MBG, NY); Greenwood, 25 April 1911, *Bush 6439* (MBG); Jasper Co., 16 Aug. 1893, *Bush* (MBG); Oronogo, 10 July 1910, *E. J. Palmer 2996* (MBG); open banks, Webb City, 19 April 1903, *E. J. Palmer 559* (MBG); Webb City, 4 May 1902, *E. J. Palmer 304* (MBG); prairie, vicinity of Pearl, 22 Aug. 1912, *Standley 9171* (US); Willard, 20 July 1919, *Blankinship* (P); Springfield, 31 July 1892, *Dewart 74* (MBG); vicinity of Springfield, 29 Aug. 1911, *Standley 8367* (US); barrens, Swan, 25 Sept. 1899, *Bush 569* (MBG); Swan, 7–9 Oct. 1915, *Eggleston 12240* (NY, US); Galena, Stone Co., 27 May 1914, *E. J. Palmer 5682* (MBG); limestone slopes, "Bald Joe," Stone Co., 30 April 1924, *E. J. Palmer 24616* (MBG); near Seligman, Barry Co.. 4 April 1926, *E. J. Palmer 29804* (MBG).

ARKANSAS: Eureka Springs, 19 April 1899, *Trelease* (MBG); top of dolomite hill along White River, near Beaver, Carroll Co., 23 Oct. 1925, *E. J. Palmer 29333* (G, MBG, NY); bluffs, Van Buren, 5 April 1929, *Demaree 6411* (US); 14 km. west of Fort Smith, 1853–4, *Bigelow* (US); Fort Smith, 1 April 1928, *Benke 4566* (G); Hot Springs, 31 Oct. 1899, *Trelease* (MBG); Malvern, *Letterman* (MBG, US); Prescott, 8 April 1900, *Bush 545* (MBG); clay barrens, Fulton, Hempstead Co., 28 April 1914, *E. J. Palmer 5407* (MBG); Red River, *Pitcher* (G).

KANSAS: Princeton, 19 May 1919, *Street* (P); between Olathe and Pleasanton, Miami Co., 18 June 1929, *Rydberg & Imler 22* (MBG, NY); open woods, Cherokee

Co., 1896, *Hitchcock 790* (G, MBG, NY, US); vicinity of Edna, 28 June 1929, *Rydberg & Imler 379* (NY).

Oklahoma: near Miami, Ottawa Co., 26 Aug. 1913, *Stevens 2340* (G, MBG, NY, US); Sapulpa, 22 July 1894, *Bush 437* (G, MBG, NY, US); Perkins, 14 June 1893, *Waugh 168* (MBG); upland woods, Muskogee, 30 June 1918, *E. J. Palmer 14283* (MBG); Norman, 17 April 1915, *Emig 415* (MBG, US); near Page, 20 May 1914, *Blakeley 1471* (G); near Paul's Valley, Garvin Co., 19 April 1913, *Stevens 109* (G, MBG); Colbert Station, 19 June 1891, *Sheldon 26* (US); near Idabel, 18 May 1916, *Houghton 3643* (G, MBG).

Texas: Denison, 22 April 1904, *Reverchon* (MBG); Denison, 15 March 1904, *Reverchon* (MBG); wet places, T. & C. Junction, Bowie Co., 5 Sept. 1900, *Eggert* (G, MBG); sandy ground north of Longview, Gregg Co., 19 April 1899, *Eggert* (MBG); open ground, Longview, 21 April 1915, *E. J. Palmer 7124* (MBG); sands, Dallas, *Reverchon* (G), *740* (MBG); Newland, near Dallas, 26 March 1901, *Reverchon 2533* (MBG, NY); Grapeland, Houston Co., 28 May 1917, *E. J. Palmer 12056* (MBG); Grapeland, 8 June 1920, *Tharp 838* (G, NY, US); Livingston, Polk Co., 10 April 1914, *E. J. Palmer 5185* (MBG); Sabine River, 25 km. north of Orange, 18 April 1899, *Bray 65* (US); Dayton, Liberty Co., 21 May 1917, *E. J. Palmer 11979* (MBG); sandy open ground, near Conroe, Montgomery Co., 15 April 1929, *E. J. Palmer 33319* (G, MBG, NY); Houston, Feb. 1842, *Lindheimer* (G); woods, Houston, 6 April 1872, *Hall 435* (MBG, NY, P, US); Houston, *Fisher* (MBG), *33, 40, 47, 707* (US); Galveston, *Van Huff* (MBG).

Colorado: Rocky Mountains, lat. 40–41′, 1868, *Vasey* (G, MBG).

Verbena canadensis is one of the most easily recognized of the North American species belonging to the section *Glandularia.* It has a large corolla with tube about twice as long as the calyx and, at maturity, an elongated spike with somewhat remote fruits and conspicuous calyx-teeth. The leaves are variously lobed or cleft. Although these variations have been used at sundry times to segregate species, they do not seem to be constant nor are they supported by definite geographic ranges, hence scarcely merit recognition.

36. **V. elegans** HBK. Nov. Gen. et Sp. **2**: 273. 1818.

V. moranensis Willd. ex Spreng. Syst. **2**: 750. 1825.

V. canadensis subsp. *elegans* Thell. Fl. Advent. de Montpellier, 428. 1912.

V. canadensis var. *Ehrenbergii* Thell. *l. c.*

Stems prostrate-decumbent, tending to root at the older nodes, more or less branched, sparsely hispidulous-hirsute; leaves lanceolate-ovate with cuneate base narrowed into a margined petiole, 2–5 cm. long, incised-pinnatifid or trifid with the divisions less deeply cleft, somewhat appressed-hirsute on both surfaces,

dark green above, lighter beneath, often with branches or fascicles of smaller leaves in the axils; spikes few-flowered, pedunculate, terminal, fascicle-like; bracts mostly one-half to two-thirds as long as the calyx, lanceolate, attenuate, glandular-hirsute, ciliate; calyx 8–10 mm. long, glandular-hirsute, teeth short, subulate and unequal; corolla-tube 15–18 mm. long, finely but sparsely pubescent without, throat gibbous; corolla-limb 10–12 mm. wide; nutlets subcylindrical, 3.5–4 mm. long, reticulate-scrobiculate chiefly on the upper half, lower part striate; commissural face muriculate.

Distribution: southern Mexico.

Specimens examined:

MEXICO:

HIDALGO: Sierra de Pachuca, 2700 m. alt., 22 July 1898, *Pringle 6908* (ANSP, F, G, MBG, NY, P, US); Sierra de Pachuca, 21 and 22 July 1901, *Rose & Hay 5556* (US); mountains, Pachuca, July 1905, *Purpus 1433* (MBG, P); between Pachuca and Real del Monte, 19 July 1905, *Rose, Painter & Rose 8668* (NY, US); Real del Monte, 9 May 1910, *Clokey* (MBG); Moran, *Humboldt & Bonpland 4063* (Bot. Mus. Berl.-Dahl. TYPE of *V. moranensis*, MBG phot.); under oaks and firs, Sierra de Ajusco, ca. 2800 m. alt., 26 Aug. 1902, *Pringle 11092* (F, G, MBG, NY, US).

MEXICO: lomas de Santa Fe, Aug. 1927, *Lyonnet 173* (US).

VERA CRUZ: near Chila, Distr. Ozuluama, April 1888, *Seler 723* (G).

OAXACA: Tehuantepec, 1906, *Gandoger* (MBG).

The above species is related to *V. canadensis* but is easily separable by its slender more or less prostrate habit, few-flowered compact spikes, and shorter calyx-teeth. The nutlets of the two are about the same size, but the reticulations in *V. elegans* are a little coarser than those in the more northern species.

36a. Var. **asperata** Perry,[23] n. var.

Stems decumbent-ascending, hirsute-hispid; leaves variously cleft or lobed; spikes dense, many-flowered; calyx glandular, hispidulous-hirsute, teeth a little longer than in the species.

Distribution: Sonora and Chihuahua to San Luis Potosi.

Specimens examined:

MEXICO:

SONORA: Sierra Madre, 15 Dec. 1890, *Lumholtz 445* (G); Badehuachi, 2 Dec. 1890, *Lumholtz 446* (G); Hermosillo, 1888, *M. A. Crawford* (G).

[23] Var. **asperata** Perry, var. nov., caules ascendentes hirsuto-hispidi; foliis bipinnatifidis vel multifidis; spicis densis multifloris; calyce glanduloso hispidulo-hirsuto.—Collected at San Antonio, Coahuila, Mexico, 31 Aug. 1848, *Gregg 355* (MBG), TYPE.

Chihuahua: southwestern Chihuahua, Aug.–Nov. 1885, *Palmer 295* (G, US).

Durango: San Ramon, 21 Apr.–18 May 1906, *Palmer 191* (G, MBG, NY, US).

Coahuila: Sierra de Parras, Oct. 1910, *Purpus 4974* (F, G, MBG, US); 72 km. east of Saltillo, July 1880, *Palmer 1052* (G, US); San Antonio, 31 Aug. 1848, *Gregg 355* (MBG type); Sierra Encarnaciore, 28 July 1896, *Nelson 3896* (US).

San Luis Potosi: near Morales, 1876, *Schaffner 716* (G); near San Luis Potosi, 1878, *Parry & Palmer 720* (ANSP, F, MBG, US); Alvarez, 5–12 Sept. 1902, *Palmer 51* (F, G, MBG, NY, US).

This variety, as compared with the species, is stouter and more erect with coarser pubescence and larger spike. *Palmer 191* differs from the other collections in having very shallowly lobed ovate leaves. *Parry & Palmer 720* shows much variation in pubescence, some plants being scabrous, others scarcely so at all. *Purpus 4974* is lacking the coarse pubescence but appears more closely allied here than elsewhere.

37. **V. maritima** Small, Bull. N. Y. Bot. Gard. 3: 436. 1905. Stems branched at base, decumbent or prostrate, sparingly pubescent or glabrate; leaves cuneate to orbicular-ovate, 1–4(–6) cm. long, tapering into a margined petiole, incised-dentate or somewhat lobed, sparsely pubescent or glabrate on both surfaces; spikes terminal, pedunculate, fascicle-like in anthesis, becoming elongate in fruit; bracts linear-lanceolate, about one-half as long as the calyx, acuminate, pubescent, ciliate; fruiting calyx 10–13 mm. long, appressed-pubescent, often glandular, teeth short, slender, subulate; corolla-tube at least one-half longer than the calyx, pubescent without; corolla-limb 10–15 mm. broad; anthers with or without glands; nutlets subcylindric with broadened base, 4 mm. long, scrobiculate; commissure narrow, muricately scabrous.

Distribution: Florida.

Specimens examined:

Florida: sandy ridges bordering the ocean, eastern Florida, *Curtiss 1963* in part (G, MBG, NY); sandy soil, Merritt's Island, 9 Dec. 1929, *Moldenke 219a* (NY); near Cape Canaveral, 15 July 1896, *Curtiss 5706* (G, MBG, NY, P, US); Cape Canaveral, 2–5 April 1904, *Burgess 638* (NY); Fort Pierce, 8–9 April 1904, *Burgess 713* (NY); sand dunes, Hobe Sound, 19 March 1921, *Randolph 52* (G); West Jupiter, 10 April 1904, *Burgess 783* (NY); near beach, Palm Beach, 19 Nov. 1914, *Small 2124* (NY); dry hammock south of Palm Beach, 1 May 1918, *Small 8509* (NY); beach opposite Miami, Nov. 1904, *Small 2100* (NY); opposite Miami, Feb. 1911, *Small, Carter & Small 3311* (NY); Cape Florida, 29 March 1904, *Britton 296* (NY); pine lands, Small Island, northwest of Perrine, 16 Jan. 1909, *Small & Carter 2994* (NY);

sandy soil, Redlands, 2 Feb. 1930, *Moldenke 549* (MBG, NY); sandy soil, Golden Beach, 10 Feb. 1930, *Moldenke 586* (MBG, NY); Camp Jackson, 25 March 1904, *Britton 220* (F, NY); Everglades, west of Camp Jackson, Dade Co., 6–9 May 1904, *Small & Wilson 1961* (NY); Royal Palm Hammock, 20 Feb. 1915, *Small & Small 5422* (NY); Paradise Key and vicinity, 21–29 Sept. 1917, *Safford & Mosier 210* (US); Hammer Key, Everglades, 12 May 1918, *Small 8594, 8599* (NY); in sand near Cocoa Beach, 16 March 1930, *O'Neill 6309* (MBG, US); between Cutler and Longview Camp, 9–12 Nov. 1903, *Small & Carter 1077* (NY).

This native of the sand dunes and the hammocks of Florida resembles *V. canadensis* in inflorescence, but is readily distinguished by the creeping habit and the cuneate or orbicular-ovate leaves.

38. **V. tampensis** Nash, Bull. Torr. Bot. Club **23**: 104. 1896.

Stems erect from a decumbent or creeping base, pubescent or glabrate; leaves ovate to oblong-ovate, 2–7 cm. long, 1.5–4 cm. broad, truncate at base, tapering into a margined petiole (2 or more cm. long), coarsely serrate-dentate or shallowly incised, strigillose or glabrate on both surfaces, paler beneath; spikes pedunculate, fascicle-like in anthesis, becoming elongated in fruit; bracts linear-subulate, about one-half as long as the calyx, strigillose, ciliate; fruiting calyx 12–13 mm. long, strigillose, lobes very slender, subulate, unequal; corolla-tube somewhat longer (about 2–4 mm.) than the calyx, pubescent without; corolla-limb 10–12 mm. broad; anthers glandless or with a minute gland on the connective of each of the upper pair; schizocarp at maturity slightly constricted along the lines of cleavage; nutlets subcylindrical with broadened base, 4 mm. long, reticulate-scrobiculate above, striate toward base; commissure minutely scabrous.

Distribution: Florida.

Specimens examined:

FLORIDA: without locality, 1842–49, *Rugel 305* (F, MBG, NY, US); Daytona, 24 Jan. 1907, *Mell* (MBG); hammock south of Daytona, 8 May 1918, *Small 8686* (NY); pine lands east of Eustis, 7 May 1918, *Small 8469* (NY); Titusville, 31 March 1914, *Mattern* (US); dry sandy soil along roadside, 3 km. east of Fort Christmas, Orange Co., 9 Dec. 1929, *Moldenke 212* (MBG, NY); hammock along Indian River, Cocoa, 9 May 1918, *Small 8732* (NY); low open woods, Indian River, June, *Curtiss 1963* in part (G, MBG, NY, US); Okeechobee region, Brevard Co., 18 April 1903, *Fredholm 5804* (G); above Fort Lauderdale, 12 March 1920, *J. P. Young 737* (US); Indian River at Biscayne Bay, 1874, *Palmer 6433* (MBG); Tampa, May 1876, *Garber* (US); Tampa, 24 Aug. 1895, *Nash 2470* (G, NY), TYPE collection; Tampa, 7 March 1898,

Pollard (US); St. Petersburg, April 1921, *Beckwith 772* (US); Palmetto, 8 May 1900, *Tracy 6650* (G, MBG, NY, US); Braden River, 13 km. southeast of Manatee, 13 June 1918, *Barrett 13* (US); dry sandy soil north of Venice, 23 April 1930, *Moldenke 1039* (MBG, NY); Owanita, Lee Co., 18 March 1907, *W. Kellogg* (G); thicket along river, Pondilla, Lee Co., 8 March 1927, *Standley* (US).

Verbena tampensis, apparently endemic in peninsular Florida, is very similar in habit to *V. canadensis*. It differs in having more shallowly incised or dentate leaves, a strigillose calyx, slightly longer nutlets, and essentially glandless anthers. The nutlets are enlarged at the base somewhat more than those of closely related species.

39. **V. tumidula** Perry,[24] n. sp.

Stems 15–20 cm. long, decumbent-ascending, branching, pilose-hirsute; leaves broadly ovate with cuneate base narrowed into a margined petiole, 2–4 cm. long, trifid with segments incised or coarsely crenate-dentate, appressed-pubescent or strigillose above, hirtellous beneath; spikes short-pedunculate, protruding slightly beyond the uppermost leaves, compact; bracts ovate-lanceolate, acuminate, not exceeding the calyx in length, ciliate; mature calyx 8–9 mm. long, inflated at base, hirsute, finely glandular, teeth subulate, 1.5 mm. long; corolla-tube about 11 mm. long, puberulent without; corolla-limb 8–10 mm. broad; anthers not glandular; nutlets 3 mm. long, dorsal surface reticulate-scrobiculate, lateral surfaces ventricose and smooth; commissural face almost smooth.

Distribution: Texas and New Mexico.

Specimens examined:

TEXAS: "from W. Texas to El Paso, New Mexico," May–Oct. 1849, *Wright 455* (G, US); Barksdale, 7 May 1918, *E. J. Palmer 13512* (MBG TYPE).

NEW MEXICO: collection of 1851–2, *Wright 1503* in part (G, NY).

[24] **V. tumidula** Perry, spec. nov., herbacea; caulibus decumbentibus vel ascendentibus ramosis piloso-hirsutis; foliis late ovatis basi cuneata in petiolum alatum contractis trifidis segmentis inciso- vel grosse crenato-dentatis subtus hirtellis supra adpresso-pubescentibus vel strigosis; spicis breviter pedunculatis paulo exsertis; bracteis ovato-lanceolatis acuminatis ciliatis calyce fere paulo brevioribus; calyce 8–9 mm. longo basim inflato hirsuto et subtiliter glanduloso; calycis dentibus 1.5 mm. longis; corollae tubo circiter 11 mm. longo extus puberulo; corollae limbo 8–10 mm. lato; connectivo antherarum superiorum inappendiculato; coccis subovoideis 3 mm. longis dorso reticulato-scrobiculatis lateribus ventricosis et glabris; commissura subtiliter muriculata.—Collected at Barksdale, Texas, 7 May 1918, *E. J. Palmer 13512* (MBG), TYPE.

This species undoubtedly belongs to the section *Glandularia*, although apparently the anthers are glandless. Superficially, it resembles *V. Gooddingii* var. *nepetifolia*, but the spikes are not so large nor so showy. Its distinctive characters are the ventricose nutlets and the inflated fruiting calyx. The bracts, too, are broader and shorter than those of nearly related species of this group.

40. **V. bipinnatifida** Nutt. Jour. Acad. Nat. Sci. Phila. **2:** 123. 1821; Schauer in DC. Prodr. **11:** 553. 1847.

Glandularia bipinnatifida Nutt. Trans. Am. Phil. Soc. N.S. **5:** 184. 1837.

More or less diffusely branched from the base; stems loosely ascending, occasionally rooting at the lower nodes or from subterranean branches, hispid-hirsute; leaves petiolate, blades 2–6 cm. long, bipinnately parted or tripartite with divisions more or less bipinnatifid, lobes linear or oblong, appressed-hirsute on both surfaces, margin at times revolute; spikes pedunculate, fascicle-like in anthesis, becoming elongate in fruit; bracts mostly longer than the calyx, linear-subulate, hispid-hirsute, ciliate; fruiting calyx 8.5–10 mm. long, pubescent, hispid-hirsute along the nerves, lobes very slender, subulate-setaceous from a broader base, unequal; corolla-tube about one-half longer than the calyx, pubescent without; corolla-limb 8–10(–12) mm. broad, lobes emarginate; nutlets cylindric with slightly broadened base, mostly 3 mm. long, reticulate-scrobiculate above, striate toward the base; commissure muricately scabrous.

Distribution: South Dakota to Alabama, westward to Arizona and northern Mexico.

Specimens examined:

ALABAMA: between Cahaba and Beloit, Dallas Co., 26 April 1927, *Harper 15* (G, NY, US); on limestone outcrops along small creeks, near Demopolis, Marengo Co., 14 May 1925, *E. J. Palmer 27209* (MBG); Spring Hill, 1918, *Graves 536, 1946* (MBG).

MISSISSIPPI: Ocean Springs, 1892, *Skehan 47* (G).

LOUISIANA: vicinity of Alexandria, 19 May 1899, *Ball 401* (G, MBG, NY, US); Cotes Blanches, St. Mary Co., 17 July 1893, *Langlois* (MBG, US).

MISSOURI: prairies, Upper Missouri, 21 June 1839, *Geyer* (US); Courtney, 6 June 1894, *Bush 351* (G, MBG); Courtney, 13 June 1906, *Bush 4029* (G, MBG, NY, US).

ARKANSAS: "Red River," *Nuttall* (G, NY), TYPE collection; dry gravelly hills, Fulton, Hempstead Co., 17 June 1915, *E. J. Palmer 8045* (MBG); near Homan, 10

June 1898, *Eggert* (MBG); along railroads, Miller Co., 19 June 1908, *Eggert* (NY); Texarkana, Aug. 1880, *Letterman* (MBG, NY).

South Dakota: Fort Pierre, *Nicollet's Northwest Expedition* (US); Pierre, 2 Sept. 1891, *T. A. Williams* (MBG, NY); near McClure, June 1910, *O. E. White* (MBG); Kennebec, Lyman Co., 1 July 1914, *Over 3177* (US); Pine Ridge Reservation, Washabaugh Co., 22 Aug. 1911, *Visher 2132* (F, NY); White River, 16 July 1896, *T. A. Williams* (NY); White River flood plain, 4 Aug. 1914, *Over 2103* (US); White River Valley, Shannon Co., 8 July 1911, *Visher 2177* (NY); Fall River Falls, 18 June 1892, *Rydberg 935* (G, NY, US).

Nebraska: Spencer, Boyd Co., 25 July 1893, *Clements 2776* (G, US); Callaway, 4 July 1901, *Bates* (G).

Kansas: Cloud Co., 19 May 1888, *Carleton* (MBG); near Osborne City, 19 May 1894, *Shear 38* (G, NY, US); Manhattan, 24 May 1901, *A. Nelson 8245* (G, MBG, NY, US); plains, Ellis Co., 16 July 1895, *Hitchcock 393* (G, MBG, NY, US); Smoky Hill, June 1867, *Parry 157* (G, MBG); vicinity of Hays, 20 July 1929, *Rydberg & Imler 1212* (NY), *1253* (MBG, NY); prairies, Medicine Lodge, 12 Sept. 1890, *Smyth 306* (US); Morton Co., July 1891, *Carleton 177* (US); vicinity of Richfield, 20 Sept. 1912, *Rose & Fitch 17105* (US).

Oklahoma: Vinita, 3 Aug. 1877, *Gurney & Monell* (MBG); Grant Co., 20 June 1899, *White 197* (MBG); Woods Co., 29 June ?1899, *White 165* (MBG); near Alva, Woods Co., 28 Sept. 1913, *Stevens 2850* (G); near Whitehorse, 31 May 1913, *Stevens 699* (G, MBG, NY, US); about 17 km. north of Boise City, Cimarron Co., 22 Aug. 1927, *Stratton 449* (MBG); near Shattuck, Ellis Co., 20 May 1914, *Clifton 3085* (G, P); Hollis, Harmon Co., 21 June 1913, *Stevens 1108* (G); 10 km. southwest of Hollis, 6 Aug. 1927, *Stratton 317* (MBG); vicinity of Fort Sill, 27 April 1916, *Clemens 11751* (MBG); on false Washita between Fort Cobb and Fort Arbuckle, 1868, *Palmer 47* (NY); Arbuckle Mountains, Davis, 29 Oct. 1914, *Emig 395* (MBG); near Davis, 23 June 1917, *Emig 788* (MBG); Mannsville, Johnston Co., April 1916, *Griffith 3456* (G); Price's Falls, Murray Co., 30 April 1926, *Stratton 10* (MBG); near Crusher Spur, Murray Co., 11 April 1913, *Stevens 14* (G, MBG, NY, US); near Camp, Texas Co., 12 May 1913, *Stevens 427* (G); Caddo, 22 June 1891, *Sheldon* (MBG), *48* (US).

Texas: without data, *Lindheimer 232* (MBG), *289* (F, G, MBG, NY, US), *307* (G); Canadian, Hemphill Co., 10 Aug. 1900, *Eggert* (MBG); Canadian, July 1903, *Howell 111* (US); vicinity of Terrell, Kaufman Co., 4 May 1904, *Tyler* (US); Dallas, *Reverchon 739* (MBG, US), *1962* (F, G, MBG, NY, US); Dallas, *Reverchon* (G, NY, US); Dallas, 22 June 1899, *Eggert* (MBG); dry ground, near Garland, 24 June 1899, *Eggert* (MBG); Fort Worth, *Ruth 107* (F, G, MBG, NY, US); Weatherford, 26 May 1902, *Tracy 7999* (F, G, MBG, NY, US); Corsicana, Navarro Co., 1 June 1915, *E. J. Palmer 7821* (MBG); near Granbury, Hood Co., 4 May 1900, *Eggert* (MBG); Granbury, 4 Sept. 1914, *E. J. Palmer 6510* (MBG); near Abilene, 7 June 1900, *Eggert* (MBG); Abilene, 19 May 1902, *Tracy 8000* (F, MBG); Killeen, 1 Oct. 1891, *Ward* (US); Walker Co., 6–12 May 1910, *Dixon 561* (F, P); near Austin, Travis Co., 18 April 1929, *E. J. Palmer 33389* (G, MBG); Crab Apple Creek, Gillespie Co., *Jermy 183* (MBG); about 25 km. west of San Felipe, March 1844, *Lindheimer 146* (MBG); San Marcos, 11 June 1897, *Trelease* (MBG); Comanche Spring, New Braunfels, *Lindheimer 1072, 1073* (F, G, MBG, NY, US); northwest of New Braunfels, 14 Sept. 1913, *Pennell 5444* (NY); limestone soil mixed with sand, near Bracken, *Groth 30* (F, G, NY, US); Rock Springs, 17 April 1930, *Jones 26228* in part (MBG); Del Rio, 18 April 1930, *Jones 26229* in part (P); Fort Clark, Kinney Co., *Mearns 1252, 1274, 1394* (US); Eagle Pass, Rio Bravo del Norte, Feb.–March 1852, *Schott*

(NY); San Antonio de Bexar, Feb. 1828, *Berlandier 1449=189* (G); between Trinity River and Bexar, June 1828, *Berlandier 429=?1749* (G); San Antonio, 4 April 1901, *Eggert* (G); San Antonio, 1897, *Wilkinson 9* (MBG); San Antonio, 15 Aug. 1906, *Ball 909* (US); vicinity of San Antonio, April 1919, *von Schrenk* (MBG); San Antonio to Austin, 18 April 1925, *Small & Wherry 11968* (NY); 16 km. west of San Antonio, 8 June 1931, *Moore & Steyermark 3001* (MBG); along Trinity River, near Liberty, 11 April 1925, *Small & Wherry 11781* (NY); Columbia, 27 March 1900, *Bush 449* (MBG, NY, US); Columbia, 3 May 1900, *Bush 205* (MBG, US); Cuero, 22 March 1907, *Howell 308* (US); prairies, near Victoria, 10 April 1900, *Eggert* (MBG); Victoria, 27 April 1905, *Maxon 3808* (US); Victoria, 7 March 1916, *E. J. Palmer 9098* (MBG); from Goliad to Bexar, May 1834, *Berlandier 2428=998* (G, MBG).

?Montana: sandy soil along Yellowstone and upper Missouri, 1853–4, *Hayden* (MBG).

New Mexico: without data, 1850–2, *Wright 1502* (G, NY, US), *1504* in part (ANSP); below Doñana, *Parry, Bigelow, Wright, Schott* (NY); Santa Fe, 20 July 1898, *Earle 84* (MBG, NY); Roswell, Aug. 1900, *Earle & Earle 526* (MBG, NY).

Arizona: Bill Williams Mountain, 22 July 1898, *MacDougal 317* (ANSP, F, G, NY); by streams of Santa Catalina Mountains, 13 April 1881, *Pringle* (G); Santa Rita Mountains, 31 July 1927, *Peebles, Harrison & Kearney 4549* (US); Miller's Canyon, Huachuca Mountains, July 1909, *Goodding 251, 495* (G, NY); road to Rustler's Park, Chiricahua Mountains, 18–19 June 1930, *Goodman & Hitchcock 1211* (MBG); Barfoot Park, Chiricahua Mountains, 31 Aug. 1906, *Blumer 1345* (F, G, MBG, NY).

Mexico: Chihuahua: near Colonia Garcia, 21 July 1899, *Townsend & Barber 139* (F, G, MBG, P, US); near Colonia Garcia, 1899, *Nelson 6117* (G, US); Round Valley, Sierra Madre, 17 Sept. 1903, *Jones* (P).

In the specimens from Arizona and Mexico, it should be noted that the pubescence is hispidulous and the spikes at maturity are, for the most part, dense rather than elongated.

The typical form of the species is very easily recognized by the hispid-hirsute pubescence, particularly of the inflorescence, the lack of glands, the long floral bracts, the elongating spike, the deeply cut leaves, and a rather coarse habit. Apparently it intergrades with *V. ciliata* in northern Mexico, with *V. ambrosifolia* in New Mexico, and at times with *V. canadensis* in the southwestern part of its range. Nevertheless, in spite of the many intermediate phases, it seems preferable to maintain each group as specific entities.

40a. Var. **latilobata** Perry,[25] n. var.

Leaves trifid with the segments remotely incised or lobed,

[25] Var. **latilobata** Perry, var. nov., folia trifida; segmentis grosse incisis lobisve supra strigosis subtusque praesertim in nervis et venis hirtellis hirsutisve; spicis maturitate densis vel elongatis.—Collected between San Pedro and Fronteras, Sonora, Mexico, 20–24 Sept. 1890, *Hartman 906* (G), type.

strigillose above, hirtellous-hirsute, especially along the veins beneath; spike compact or somewhat elongated in age; bracts variable in length, usually equalling or exceeding the calyx; floral and nutlet characters as in the species.

Distribution: southern Arizona and northwestern Mexico.

Specimens examined:

Arizona: Galiuro Mountains, 9 July 1894, *Toumey* (NY); Bisbee, Oct. 1908, *Goodding 37* (NY); Flagstaff, 17 June 1887, *Mearns* (NY); Fort Huachuca, Aug. 1893, *Wilcox* (NY); Fort Huachuca, Sept. 1894, *Wilcox* (US); Huachuca Mountains, 29 June–5 July 1903, *Griffiths 4833* (US); Huachuca Mountains, 3 Sept. 1903, *Jones* (P); Miller's Canyon, Huachuca Mountains, 26 Aug. 1910, *Goodding 883* (G, NY); Santa Rita Mountains, 20 Sept.–4 Oct. 1902, *Griffiths & Thornber 159* (US); Santa Rita Mountains, 24 Aug. 1903, *Jones* (P, US).

Mexico:

Chihuahua: at base of Mt. Mohinora, about 13 km. from Guadalupe y Calvo, 23–31 Aug. 1898, *Nelson 4856* (G, US); Colonia Juarez, Sierra Madre Mountains, 11 Sept. 1903, *Jones* (P); San Diego Canyon, Sierra Madre Mountains, 16 Sept. 1903, *Jones* (P); without data, *Wright 1503* in part (G, NY).

Sonora: between San Pedro and Fronteras, 20–24 Sept. 1890, *Hartman 906* (G type); San Pedro, 14 Sept. 1890, *Hartman 880* (G); Cananea, 27 Sept. 1908, *Donnelly* (P); Cananea, 20 Aug.–1 Sept. 1914, *Murdoch* (F).

Durango: without data, *Garcia 331* (US); Sierra Madre, west of Durango, Sept.–Oct. 1881, *Forrer* (F).

The variety differs from the species chiefly in foliar characters.

41. **V. ambrosifolia** Rydb. in Small, Fl. Southeast. U. S. ed. 1, 1011. 1337. 1903, and ed. 2, 1913.

More or less diffusely branched from the base; stems loosely decumbent-ascending, somewhat hirsute; leaves short-petiolate, blades 2–6 cm. long, bipinnatifid with the ultimate segments lanceolate, appressed-hirsute on both surfaces, margin slightly revolute; spikes pedunculate or subsessile, fascicle-like in anthesis, somewhat elongating in fruit; bracts a little shorter than the calyx, lance-subulate, hirsute, ciliate; fruiting calyx 8–9 mm. long, glandular, pubescent, hirsute particularly along the nerves; teeth subulate; corolla-tube protruding one-third to one-half beyond the calyx, pubescent without; corolla-limb 6–8(–10) mm. wide; nutlets subcylindric often with slightly broadened base, 2.5–3 mm. long, reticulate-scrobiculate above, striate below; commissure muricately scabrous.

Distribution: Oklahoma and Texas to Arizona and northern Mexico.

Specimens examined:

Oklahoma: near Kenton, Cimarron Co., 15 May 1913, *Stevens 484* (G, MBG).

TEXAS: 16 km. east of Comstock, 9 June 1931, *Moore & Steyermark 3009* (MBG); Alpine, 30 May 1928, *E. J. Palmer 34240* (NY); prairies near Marfa, 14 May 1901, *Eggert* (MBG); foothills below McKittrick Canyon, 23 July 1931, *Moore & Steyermark 3622* (MBG); Sierra Blanca, May 1913, *Orcutt 6096, 6197* (MBG); northeast base of Quitman Mountains, near Sierra Blanca, 4 July 1921, *Ferris & Duncan 2474* (MBG).

COLORADO: New Windsor, 18 June 1905, *Osterhout 3165* (G); Boulder, July 1891, *Penard 348* (NY); Denver, July 1892, *Eastwood* (NY); South Denver, 8 June 1891, *E. C. Smith* (MBG); foothills, below Colorado Springs, 29 May 1878, *Jones 122* (P); Cañon City, May 1871, *Brandegee* (MBG); Pueblo, 10 July 1873, *Greene 45* (G); road to Walsenburg, Pueblo, 13 June 1917, *E. L. Johnston 986* (MBG); mesas near Pueblo, 14 May 1900, *Rydberg & Vreeland 5676* (NY); Rocky Ford, Otero, 8 June 1900, *Osterhout* (G fragm., NY TYPE); vicinity of La Junta, 26 Sept. 1913, *Rose & Fitch 17504* (MBG, US).

NEW MEXICO: collection of 1847, *Fendler 586* in part (ANSP, F, G, MBG, US); south of Raton on the road to Taos, 30 June 1929, *Mathias 545* (MBG); Tierra Amarilla, Rio Arriba Co., 18 April–25 May 1911, *Eggleston 6644* (US); Ojo Caliente, near Fairview, 18 July 1904, *Wooton* (US); in canyon near Santa Fe, 29 June 1846, *Wislizenus 525* (MBG); about Santa Fe, 8–9 Sept. 1881, *Engelmann* (MBG); near Pecos, San Miguel Co., 15 Aug. 1908, *Standley 4951* (F, G, MBG, NY, US); Pecos, 18 June 1927, *Arsène 18615* (P); vicinity of Las Vegas, *Anect 100, 143* (G), *179* (NY), *Arsène 18793* (P); Nara Visa, 21 April 1911, *Fisher* (MBG); vicinity of Bernalillo, 12 July 1926, *Arsène & Benedict 16306* (MBG); vicinity of Albuquerque, 6 Oct. 1913, *Rose & Fitch 17801* (MBG, US); near Albuquerque, 21 June 1926, *E. J. Palmer 31192* (MBG); between Carrizozo and Socorro, 21 July 1928, *Wolf 2890* (P); Socorro, May 1881, *Vasey* (F, MBG, US); White Mountains, Lincoln Co., Aug. 1897, *Wooton 363* (G, MBG, NY, P); Capitan, 8–19 May 1902, *Earle 638* (NY); Lincoln, 31 July 1900, *Earle & Earle 236* (MBG, P); South Spring, 2–4 May 1903, *Griffiths 4244* (US); Mimbres River, Grant Co., 20 Aug. 1904, *Metcalfe 1231* (MBG); plains south of White Sands, Doña Ana Co., 28 Aug. 1897, *Wooton 642* (MBG, NY, US); Queen, 2 Aug. 1909, *Wooton* (MBG, US); Organ Mountains, Doña Ana Co., 16 Aug. 1893, *Wooton* (MBG).

ARIZONA: Warsaw Mill, Pima Co., 3 Dec. 1893, *Mearns 2677* (MBG, NY, US); about 3 km. south of Holbrook, 17 June 1901, *Ward* (NY, US); Little Colorado, 1869, *Palmer* (US).

MEXICO:

CHIHUAHUA: Candelaria Mountains, 1911, *Stearns 104* (US).

NUEVO LEON: Monterey, 17–26 Feb. 1880, *Palmer 1050* (MBG, US).

COAHUILA: about 9 km. east of Saltillo, April 1880, *Palmer 1050* (G); Sierra Mojada, 20 April 1892, *Jones 634* (P); Sabinas, 21 May 1902, *Nelson 6789* (NY, US); Carneros Station, 31 May 1890, *Pringle 3467* (F); fields near Carneros Station, 10 Nov. 1904, *Pringle 13157* (F, G, US).

An examination of the type specimens of *V. ambrosifolia* and *V. Wrightii* reveals differences probably sufficient to suggest distinct but closely related species. Typically the former is characterized by long calyx-teeth and coarser pubescence; whereas the latter has short calyx-teeth, finer and somewhat viscid pubescence. On the other hand, a study of the aggregate

specimens of the two shows a high variability in the combination of these characters; moreover, their geographic ranges practically coincide. For these reasons, *V. ambrosifolia* is maintained as a species with very doubtful status.

41a. Forma **eglandulosa** Perry,[26] new form.

Differing from the species only in the more hirsute-hispid pubescence of the flower and the lack of glands.

Distribution: Texas to Arizona, and Sonora, Mexico.

Specimens examined:

TEXAS: "El Paso to Monument no 53," Sept. 1892, *Wagner 974* (US).

NEW MEXICO: Albuquerque, 21 June 1926, *E. J. Palmer 31153* (MBG); 8 km. west of Magdalena, 20 July 1904, *Wooton 2835* (US); Organ Mountains, 14 July 1897, *Wooton* (US); mesa just west of Organ Mountains, 13 June 1906, *Standley* (US); Santa Rita, 1 Aug. 1911, *Holzinger* (MBG TYPE, US); Deming, 13 July 1917, *Munz 1231* (P); Los Playas, 1854–5, *Antisell 186* (NY); near White Water, 11 Sept. 1893, *Mearns 2278* (US); Animas Valley, 2 Oct. 1893, *Mearns 2486* (US).

ARIZONA: Douglas, 13 May 1915, *Carlson* (G, US); Santa Catalina Mountains, 15 Sept. 1896, *Toumey* (NY, US); Dragoon, 18 July 1920, *W. W. Jones 185* (G); Cochise, 12 Oct. 1900, *Griffiths 1919* (NY).

MEXICO: SONORA: San Pedro River, 15 Oct. 1892, *Mearns 1138* (US).

This is a phase of the species lacking glands and only separable from *V. bipinnatifida* by the short bracts.

42. V. Wrightii Gray, Syn. Fl. N. Am. 2^1: 337. 1878.

Stems usually several from a common base, decumbent-ascending to erect, branched, sparsely hispid-hirsute; leaves subsessile or contracted into a short margined petiole, blades 2–3 (–4) cm. long, bipinnatifid or trifid, with the divisions more or less deeply incised, ultimate segments narrowly lanceolate, hirtellous to hirsute on both surfaces; spikes short-pedunculate, in fruit more or less compact; bracts shorter than the calyx, lanceolate, acute or acuminate, hirsute-ciliate; fruiting calyx 7–9 mm. long, densely glandular, somewhat viscid-pubescent, nerves hirsute, lobes short, subulate, unequal; corolla-tube 11–12 mm. long, pubescent around the throat; corolla-limb 6–8 mm. broad, lobes retuse; nutlets 2.5–3 mm. long, reticulate-scrobiculate above, striate toward the base; commissure muricately scabrous.

[26] Forma **eglandulosa** Perry, forma nova; calyce hirsutiori-hispido eglanduloso.—Collected at Santa Rita, New Mexico, 1 Aug. 1911, *Holzinger* (MBG), TYPE.

Distribution: Texas, Colorado, New Mexico, and Arizona.

Specimens examined:

TEXAS: San Antonio, *Havard* (US); Barstow, 16 April 1902, *Tracy & Earle 61* (F, G, MBG); northeast of Grand Falls, 17 May 1917, *Clawson 13923* (US); near Feodora, Terrell Co., 26 May 1928, *E. J. Palmer 33583* (MBG); Upper Blue Creek Canyon, Chisos Mountains, 1 July 1931, *Moore & Steyermark 3324* (MBG); Fort Davis, 9–12 July 1921, *Ferris & Duncan 2647* (MBG, P); Davis Mountains, 23 April 1902, *Tracy & Earle 162* in part (F, G, MBG, US); foothills, Davis Mountains, 15 April–3 May 1902, *Tracy & Earle 162a* (NY); canyon of Upper Limpia Creek, 10 June 1926, *E. J. Palmer 30672* (MBG); Guadalupe Mountains, 9 Sept. 1916, *Young* (MBG); flats near Van Horn, 13 May 1901, *Eggert* (G, MBG); Vieja Mountain, Oct. 1883, *Havard 97* (G, US); Canutillo, Franklin Mountains, 12 July 1911, *Barlow* (US); mountains near Fronteras, 22 March 1852, *Wright* (MBG, NY), *1504* in part (G TYPE); Hueco Mountains, March 1851, *Thurber 143* (G); about 8 km. north of Shafter, 10 April 1919, *Hanson 551* (MBG, US).

COLORADO: Durango, 20 July 1898, *Baker, Earle & Tracy 531* (G, MBG, P).

NEW MEXICO: without locality, 1851–2, *Wright 1503* in part (MBG); Copper Mines, 28 July 1851, *Bigelow* (NY); Rabbit Ear Creek, 28 June 1846, *Wislizenus 483* (MBG); Las Vegas, 26 June 1895, *Mulford 37* (MBG, NY); hills, Santa Fe, 15 May 1897, *Heller 3536* (G, MBG, P); Sandia Mountains, 6 Sept. 1884, *Jones 457* (P); Sandia Mountains, 28 April 1914, *Ellis 17* (MBG); about 3 km. east of Albuquerque, 1915, *Kammerer 33* (MBG); Albuquerque, Sept. 1884, *Jones* (NY, P); Albuquerque, 5 Sept. 1909, *Rusby* (NY); mountains west of Grant's Station, 2 Aug. 1892, *Wooton* (US); South Camp, Magdalena Mountains, July 1897, *Herrick 704* (US); White Mountains, Lincoln Co., 20 Aug. 1897, *Wooton 364* (G, MBG, P); near Lincoln National Forest, 1903, *Plummer* (US); Vaughn, 10 Sept. 1921, *Harwood* (P); plains, White Sands, Otero Co., 25 Aug. 1899, *Wooton* (US); High Rolls and vicinity, 21–28 May 1902, *Viereck* (ANSP); Alamogordo, 7 April–24 May 1902, *Rehn & Viereck* (ANSP, MBG, P); Kingston, Sierra Co., 9 July 1904, *Metcalfe 1090* (G, MBG, NY, P, US); Gallina's Canyon, Black Range, Grant Co., 17 Aug. 1915, *Pilsbry* (ANSP); Mangas Springs, about 29 km. northwest of Silver City, 11 June 1903, *Metcalfe 126* (G, MBG, P); near Silver City, June 1880, *Greene* (MBG, P); Silver City, 8 May 1919, *Eastwood 8468* (G); Rincon, 16 May 1890, *Jones* (P); Big Burros Ranger Station, Gila Forest, Grant Co., 11 Sept. 1920, *Eggleston 17231* (MBG, NY); Organ Mountains, 8 May 1895, *Wooton* (P); Organ Mountains, 11 June 1906, *Standley* (MBG, US); Filmore Canyon, Organ Mountains, Doña Ana Co., 25 May 1905, *Wooton* (US); Van Pattens, Doña Ana Co., 29 Aug. 1894, *Wooton* (US); Slaughter Canyon, 12–20 Aug. 1924, *Standley 40625* (US).

ARIZONA: Long H. Ranch to St. John's, 6–15 Aug. 1913, *Griffiths 5190* (US); between Springerville and St. John's, Apache Co., 15 Sept. 1917, *Marsh 14224* (MBG).

On account of its strong variability, this species has been exceedingly difficult to define. It was first set apart as an erect annual, with anther-glands as high and almost as large as the anther-cells. In the series of specimens at hand, the anther-glands are neither constant in size nor in height relative to the anther-sacs. The main characters appear to be the glandular somewhat viscid pubescence of the calyx, the very short acute-subulate calyx-teeth, and the somewhat compact spikes.

43. V. ciliata Benth. Pl. Hartw. 21. 1839.

Stems several from a common base, decumbent, branched, hirsute-hispidulous; leaves short-petiolate or subsessile, subbipinnatifid or commonly trifid, with the divisions more or less deeply incised, ultimate segments linear-oblong with slightly revolute margin, hirsute-strigillose on both surfaces; spikes subsessile or short-pedunculate, in fruit more or less compact; bracts a little shorter than the calyx, lanceolate, subulate or acuminate, hirsute-ciliate; calyx 7–8 mm. long, somewhat glandular, hirsute-hispidulous, lobes short, subulate, unequal; corolla-tube 10–12 mm. long, pubescent without; corolla-limb 6–8 mm. broad, lobes retuse; nutlets 2.5–3 mm. long, reticulate-scrobiculate above, striate toward base; commissural faces muricately scabrous.

Distribution: New Mexico, Arizona to southern Mexico.

Specimens examined:

NEW MEXICO: "Upper Corner Monument, parallel 31° 47′," 3 May 1892, *Mearns 108* (G, NY).

ARIZONA: without locality, 1892, *Toumey 305½* (US); Ash Fork, 18 June 1901, *Barber 106* (US); Ash Fork, 20 June 1903, *Griffiths 4757* (US); Aguila, 3 April 1930, *Jones 26231* (MBG, P); Snowflake, 30 July 1897, *Zuck* (US); Pinedale, 1–15 Aug. 1897, *Hough 109* (US); Fort Grant, Bonita, 18 July 1917, *Munz 1249* (P); between Tombstone and Bisbee, 23 May 1928, *Peebles 5353* (US).

MEXICO: without data, *Coulter* (ANSP); without locality, 26 July 1885, *Schumann 1071* (G, US).

SONORA: San Bernardino, Aug. 1852, *Thurber 769* (G).

CHIHUAHUA: Saint Eulalia plains, 26 Sept. 1885, *Wilkinson* (US); highlands near Chihuahua, 28 April 1847, *Gregg* (G, MBG, NY); valley near Chihuahua, 13 Sept. 1846, *Pringle 1117* (F, US); vicinity of Chihuahua, 8–27 April 1908, *Palmer 79* (F, G, MBG, NY, US); vicinity of Madera, 27 May–3 June 1908, *Palmer 281* (G, NY, US).

DURANGO: Valley of Nazas, Bolson de Mapimi, 11 May 1847, *Gregg 632* (MBG); near El Salto, 12 July 1898, *Nelson 4559* (MBG, US); Durango and vicinity, April–Nov. 1896, *Palmer 345* (F, G, MBG, NY, US); Durango, 1 Aug. 1898, *Nelson 4604* (MBG, US); Otinapa, 25 July–5 Aug. 1906, *Palmer 401* (F, G, MBG, NY, US).

COAHUILA: near Saltillo, 1847, *Gregg 57, 257* (MBG); Saltillo, 15–30 April 1898, *Palmer 74* (F, G, MBG, NY, US); Saltillo, 24 Aug. 1926, *Fisher 223* (US); Oro, 18 Aug. 1903, *Rose & Painter 6431* (US); La Ventura, 2–5 Aug. 1896, *Nelson 3920* (US); Parras, March 1905, *Purpus 1095* (NY); Valley of Nazas, 1848–49, *Gregg 26* (MBG); El Toro, near Movano, July 1910, *Purpus 4524* in part (F, MBG).

SAN LUIS POTOSI: near San Luis Potosi, 1876, *Schaffner 717* (ANSP, G); near San Luis Potosi, 1878, *Parry & Palmer 719* (ANSP, MBG).

ZACATECAS: Zacatecas, July 1904, *Kuntze 424* (NY); Hacienda de Cedros, 1908, *Lloyd 159* (US); near Plateado, 3 Sept. 1897, *Rose 2769* (US); near San Juan Capistrano, 19 Aug. 1897, *Rose 2435* (US).

AGUASCALIENTES: near Aguas Calientes, 9 Oct. 1903, *Rose & Painter 7742* (US).

NAYARIT: Tepic, 5 Jan.–6 Feb. 1892, *Palmer 2055* (US); Ixtlan, 19 Feb. 1927, *Jones 23244* (MBG, NY, P).

JALISCO: near Guadalajara, 11 Aug. 1902, *Pringle 11091* (F, MBG, NY, US); near Guadalajara, 23 Feb. 1907, *Safford 1398* (US); Guadalajara, Aug. 1909, *Furness* (F, US); Rio Blanco, June–Oct. 1886, *Palmer 35* (G, NY, US).

GUANAJUATO: Leon, 1839, *Hartweg 176* (G, NY), TYPE collection; Guanajuato, 1894, *Duges 496, 496a* (G); Obregon, 28 July 1926, *Fisher 207* (US).

QUERETARO: near San Juan del Rio, 17 Aug. 1905, *Rose, Painter & Rose 9503* (US); Queretaro, 1910–13, *Arsène & Agniel 10252* (F, G, MBG, NY, US).

HIDALGO: above Pachuca, 23 July 1898, *Pringle 7591* (F, P).

VERA CRUZ: Orizaba, 1853, *Mueller 325, 1209, 1319* (NY); Orizaba, 4 Aug. 1891, *Seaton 150* (F, G, US); Maltrata, Jan. 1883, *Kerber 255* (US); Maltrata, 16 Aug. 1891, *Seaton 391* (F, G, NY, US).

PUEBLA: Cholula, 1 Jan. 1899, *Deam* (F), *86* (G); Tehuacan, *Galeotti 736* (NY, US); near Tehuacan, 8 Sept. 1906, *Rose & Rose 11398* (G, NY, US); vicinity of San Luis Tultitlanapa, July 1908, *Purpus 3407* (G, MBG).

MEXICO: meadows near Lecheria, 12 May 1904, *Pringle 13158* (F, G, US); Valley of Mexico, 1865–6, *Bourgeau 120* (G); Eslava, 15 June 1901, *Pringle 9313* (G, MBG, NY, US); Amecameca, 24 July 1924, *Fisher* (F), *319* (MBG, US); near San Angel, 9 April 1849, *Gregg 648* (MBG).

MICHOACAN: low valley, Zinapecuaro, 2 May 1849, *Gregg 756* (MBG); Querendaro, 28 Oct. 1895, *Seler 1174* (G); Los Reyes, 8–12 Feb. 1903, *Nelson 6858* (US).

COLIMA: volcano of Colima, 14 July 1892, *Jones 686* (P).

OAXACA: Cerro de las Soledad, 20 Nov. 1895, *Seler 1379* (G); Las Sedas, 8 Sept. 1894, *C. L. Smith 221* in part (US).

This is a variable and wide-ranging species closely related to the *bipinnatifida-Wrightii-ambrosifolia* complex and scarcely capable of sharp delimitation. Its best characters are the hirsute-hispid pubescence, the usually sessile compact spike, the medium-short somewhat glandular calyx subtended by a slightly shorter bract. The specimens, *Seaton 150*, *Pringle 9313*, and *Gregg 648*, have typical spikes, but the leaves are small and the stems tend to be repent, suggesting a possible intergradation with *V. teucriifolia*.

43a. Var. **longidentata** Perry,[27] n. var.

Hispidulous-hirsute plant of variable size and more or less open habit; leaves bipinnatifid; calyx-teeth 2–2.5 mm. long.

Distribution: southern Texas, New Mexico, and Tamaulipas.

Specimens examined:

TEXAS: Post, 22 May 1925, *Wooton* (US); Lubbock, 14 May 1930, *Demaree 7685*

[27] Var. **longidentata** Perry, var. nov., planta hispidulo-hirsuta; foliis bipinnatifidis; calycis dentibus 2–2.5 mm. longis.—Collected at Matamoros, Mexico, April 1836, *Berlandier 3020* (MBG), TYPE.

(US); Vista, May 1892, *Trelease* (MBG); woods near Colorado River, near Wharton, 12 April 1925, *Small & Wherry 11834* (NY); hills near San Antonio, 4 April 1901, *Eggert* (MBG); El Jardin, 10 March 1924, *Runyon 630* (US); Laredo, Feb.–March 1913, *Orcutt 5657* (MBG); Corpus Christi, 11 May 1900, *Bailey 258* (US); Corpus Christi, May 1913, *Orcutt 5792* (MBG); Aransas Pass, 1922, *Schulz 845* (US); Kingsville, 25 March 1920, *High 59* (MBG); Brownsville, 4 May 1900, *Bailey 221* (US).

New Mexico: Hagerman, 26 April 1929, *Benke 5046* (F, G, MBG).

Mexico: Tamaulipas: Matamoros, April 1836, *Berlandier 1520* (G), *3020* (G, MBG type, NY).

Scarcely differing from the species except in the relatively very long calyx-teeth and the often somewhat less deeply cleft leaves.

43b. Var. **pubera** (Greene) Perry, n. comb.

V. pubera Greene, Pittonia **5**: 136. 1903.

Plants with more or less prostrate compact habit; ultimate segments of the leaves linear-oblong, margins strongly revolute.

Distribution: Texas to Arizona.

Specimens examined:

Texas: Davis Mountains, 23 April 1902, *Tracy & Earle 162* in part (MBG), type collection of *V. pubera;* Sierra Blanca, El Paso Co., 22 May 1913, *Orcutt 6172* (MBG).

New Mexico: low mountains west of San Antonio, 14 April 1908, *Wooton 3849* (US); near Silver City, May 1880, *Greene* (MBG, P); Deming, 29 April 1884, *Jones 3801* (NY, P, US); Deming, 9 April 1930, *Jones 26232* (MBG, P); Lordsburg, 3 July 1891, *Evans* (MBG); east of Lordsburg, 5 May 1930, *Jones 26227* (MBG, P); Hudson Hot Springs, 2 April 1901, *Vreeland 804* (NY).

Arizona: Cameron's, 16 June 1929, *Jones* (P); northeast of Flagstaff, 8 Aug. 1922, *Hanson A146* (F, MBG, NY); Peach Springs, 15 June 1930, *Jones 25480* (MBG, P); Dewey, 16 July 1922, *W. W. Jones 180* (G); Taylor, 1 Aug. 1897, *Zuck* (MBG, NY); Chiricahua Mountains, 5 April 1897, *Toumey* (US).

This variety is a low plant with several stems from a common base, short internodes, and a tendency to branch freely. The leaves are more finely dissected than in the species and the margins are more revolute.

44. **V. racemosa** Eggert, Torreya **2**: 123. 1902.

V. pulchella Greene, Pittonia **5**: 136. 1903.

Stems several from a common base, ascending-erect, branched, pubescent; leaves bipinnatifid or trifid with segments deeply cleft, ultimate segments linear, somewhat pubescent or hirtellous on both surfaces; spikes subsessile, elongate but dense at maturity; bracts scarcely so long as the calyx, lanceolate, acuminate, ciliate; calyx 5–6 mm. long, sparsely glandular-hirtellous, teeth

short, acute-subulate; corolla-tube 7–9 mm. long, puberulent or glabrous without; corolla-limb 5–6 mm. broad; nutlets 2 mm. long, reticulate-scrobiculate almost to base; commissural faces muricately scabrous.

Distribution: Texas, New Mexico?

Specimens examined:

Texas: Upton Co., 2 May 1929, *Cory 664* (G); Stockton, June 1881, *Havard* (US); foothills of Davis Mountains, 21 April 1902, *Tracy & Earle 106a* (F, G); low valleys near Sierra Blanca, El Paso Co., 15 May 1901, *Eggert* (G, MBG); Sierra Blanca, 22 May 1913, *Orcutt 6184* (MBG); valley of the Rio Grande below Doñana, *Parry Bigelow, Wright & Schott* in part (US).

New Mexico: without locality, 1851–2, *Wright ?1498* (NY), *1501* (G).

Fine pubescence, short calyx-teeth, small leaves, and elongated profusely floriferous spikes are the distinctive characters of this species. It is probably a close relative of *V. ciliata.*

45. **V. Andrieuxii** Schauer in DC. Prodr. **11**: 553. 1847.

Stems diffuse; branches procumbent, sub4-angled, hispid; leaves 4 cm. long, cuneate at base, sessile, deeply trifid, rugose with veins impressed above, strigose-hispid on both sides, middle lobe pinnatifid, lateral lobes spreading, lanceolate, acutish, margin incised or entire, subrevolute; spikes terminal and axillary, short-pedunculate, oblong, crowded, hispid, subglandular; bracts one-third shorter than the calyx, subulate-lanceolate; calyx 8–9 mm. long, teeth subulate; corolla-tube one-half longer than the calyx, puberulent, corolla-limb medium; schizocarp one-half the length of the calyx.

Distribution: southern Mexico.

Specimens examined:

Mexico:

?Mexico: between Mexico and Oaxaca, *Andrieux 138* (DeCandolle Herb. type, F phot., K, MBG phot.).

Oaxaca: mountain ridge, west side of valley of Cuicatlan, 10 Nov. 1894, *Nelson 1895* (US); Tieneguilla, 5 April 1895, *L. C. Smith 348* (G); valley of Oaxaca, 2 Oct. 1894, *Nelson 1513* (G, US).

The above description is a close translation of the original. Even with the photograph of the type, the species is difficult to interpret without floral dissections. For the present, it seems preferable to maintain its status, referring here the above somewhat similar collections.

46. V. teucriifolia Mart. & Gal. Bull. Acad. Brux. **11**[2]: 322. 1844.

V. exilis Schauer in DC. Prodr. **11**: 553. 1847.

Stems several from a common base, prostrate or repent, more or less diffusely branched, 4-angled, glabrate or hirtellous; leaves 1.5–2.5 cm. long, cuneate at base, narrowed into a margined petiole, pinnatifid-incised, segments linear-oblong, obtusish, often glabrous or sparsely strigillose on both surfaces, nerves impressed above, subglaucescent beneath; margin slightly revolute; spikes terminal, sessile or short-peduncled, scarcely emerging from the highest leaves, few-flowered; bracts approximately one-half as long as the calyx, lanceolate, acuminate-acute, ciliate; calyx 5–7 mm. long, sparsely hirtellous or occasionally hirsute, lobes short, acute; corolla-tube a little longer than the calyx; corolla-limb 5–7 mm. broad; anther-glands minute; nutlets 2.5–3 mm. long, chiefly reticulate-scrobiculate; commissural face muriculate or almost smooth.

Distribution. Mexico and Guatemala.

Specimens examined:

MEXICO:

SAN LUIS POTOSI: Huaxalote, *Ehrenberg 131* (Bot. Mus. Berl.-Dahl. TYPE of *V. exilis;* MBG phot.).

GUANAJUATO: Cerro Leon, June–July 1841, *Liebmann 11329* (US).

HIDALGO: near Real del Monte, 2 June 1899, *Rose & Hough 4484* (US).

VERA CRUZ: sand hills, Perote, *Halsted* (NY); Perote, near Jalapa, 1894, *C. L. Smith 1474* (G); peak of Orizaba, June–Oct. 1840, *Galeotti 777* (K), TYPE collection; Vaqueria del Jacal and Orizaba, Oct. 1841, *Liebmann 11328* (US); "Talvare," Feb. 1843, *Liebmann 11330* (US); Boca del Monte, 13 March 1894, *Nelson 196, 223* (US).

PUEBLA: common in dry volcanic sand, Chalchicomula, 8 April 1890, *Stone* (ANSP); Chalchicomula, 20 Feb. 1892, *J. G. Smith 464* (MBG); near Chalchicomula, 15 March 1894, *Nelson 242* (US); Popocatepetl, 7–8 Aug. 1901, *Rose & Hay 6049* (US).

MEXICO: La Cima, Jalapa, Aug. 1904, *Kuntze 23738* (NY); Sierra de las Cruces, Salazar, 13 Aug. 1896, *Harshberger 41* (ANSP, G, US); lava beds, near Eslava, 19 July 1910, *Rusby 124* (NY); near Toluca, 23 June 1889, *Pringle 2927* (F, G); valley of Toluca, 15 Aug. 1892, *Pringle 4180* (ANSP, F, G, MBG, NY, US); San Angel, 12 Aug. 1910, *Orcutt 3551* (F, MBG, US).

MORELOS: Toro, 5 Aug. 1924, *Fisher* (F, MBG), *337* (US); Tres Marias, 11 Aug. 1906, *Pringle 13792* (G, US).

MICHOACAN: Morelia, 9 July 1910, *Arsène* (F).

OAXACA: Chinantla, May 1841, *Liebmann 11308, 11316* (US).

CENTRAL AMERICA: GUATEMALA: near Quezaltenango, 23 June 1882, *Lehmann 1603* (US); Quezaltenango, Oct. 1886, *von Tuerckheim 1068* (ANSP, G, US).

The specimens cited vary greatly in degree of pubescence. The larger number are sparsely hirtellous or strigillose. The following are densely hirtellous-hirsute: *Liebmann 11329, Nelson 196, 223, Smith 1474, Halsted, Smith 464, Nelson 242.*

The Guatemalan collections appear to be conspecific, although both the cilia of the bracts and the trichomes along the nerves of the calyx are somewhat coarser and stiffer than those of the Mexican material. *V. teucriifolia* is a slender plant easily separated from its nearest relatives by its prostrate or repent habit and few-flowered spikes.

46a. Var. **corollulata** Perry,[28] n. var.

Usually finely and densely pubescent; calyx 5 mm. long, spreading-pubescent, lobes very short; corolla inconspicuous, tube barely protruding beyond the calyx, limb 3 mm. broad; nutlets 2.5 mm. long.

Distribution: Mexico.
Specimens examined:
MEXICO:
SAN LUIS POTOSI: region of San Luis Potosi, 1878, *Parry & Palmer 718* (G, MBG TYPE, US), *719* in part (ANSP, F, MBG, US).
ZACATECAS: plains, LaHonda, 18 Aug. 1890, *Pringle 3551* (G); Zacatecas, 1903, *Purpus 137* (US).
HIDALGO: Hacienda Palmar, near Pachuca, 21 July 1905, *Rose, Painter & Rose 8823* (G, NY, US); Telles, Sept. 1910, *Orcutt 4146* (F, MBG).

The variety differs from the species chiefly in its smaller corollas; perhaps it is only a dimorphic form.

47. **V. Gooddingii** Briq. Ann. Conserv. & Jard. Bot. Genève **10**: 103. 1907.

V. verna var. *fissa* Nelson, Am. Jour. Bot. **18**: 437. 1931.

Stems usually several from a common base, erect or decumbent-ascending, cinereous-green, branched, densely pilose or somewhat villous, often glandular; leaves 3–5 cm. long, tapering at the base into a short margined petiole, 3-cleft, divisions coarsely toothed or incised, cinereous-green, more or less villous-hirsute

[28] Var. **corollulata** Perry, var. nov., planta dense pubescens; calyce 5 mm. longo patenti-pubescente; corolla inconspicua, tubo vix exserto, limbo 3 mm. lato; coccis 2.5 mm. longis.—Collected in the region of San Luis Potosi, Mexico, 1878, *Parry & Palmer 718* (MBG), TYPE.

on both surfaces, midrib and veins slightly prominent beneath, margins scarcely (if at all) revolute; spikes pedunculate, fascicle-like in anthesis, somewhat elongated in fruit; bracts usually a little shorter than the calyx, lanceolate, acuminate, villous-hirsute, long-ciliate; calyx 8.5–11 mm. long, villous-hirsute, more or less glandular, lobes slender, subulate, unequal; corolla-tube very little longer than the calyx, pubescent without; corolla-limb 8–9(–12) mm. wide, segments retuse; nutlets 3(–3.5) mm. long, subcylindric, reticulate-scrobiculate except at the striate base.

Distribution: Utah, Arizona to California, and Lower California.

Specimens examined:

UTAH: southern Utah, 1876, *Johnson* (US).

NEVADA: sandy soil, Charleston Mountains, about 1800 m. alt., May–Oct. 1898, *Purpus 6061* (P, US); Trout Creek, Charleston Mountains, about 1900 m. alt., 1926, *Jaeger* (P); Calientes, about 1400 m. alt., 29 April 1914, *Jones* (P); Kernan, Valley Meadow Wash, 28 April 1902, *Goodding 645* (F, G, MBG, P), TYPE collection.

ARIZONA: without locality, 1891, *MacDougal 603* (NY); Chloride, about 1350 m. alt., 15 April 1903, *Jones* (P); Hackberry, 24 May 1884, *Jones* (F, P, US); Peach Springs, June 1884, *Lemmon* (US); Peach Springs, April 1893, *Wilson 99* (US); Kingman, 11 March 1912, *Wooton* (US); Skull Valley, about 1300 m. alt., 28 April 1903, *Jones* (P); Hillside, about 1100 m. alt., 1 May 1903, *Jones* (P); near Williams, 11 April 1905, *Wilcox* (US); Jerome Divide, 25 July 1921, *W. W. Jones* (MBG); east of Jerome Junction, 1 May 1908, *Tidestrom 898* (US); Rio Verde, Fort Whipple, 30 Aug. 1865, *Coues & Palmer 498* (MBG); Fort Verde, 1888, *Mearns* (NY); Natural Bridge, 23 April 1904, *F. M. Chamberlain 56* (US); Bradshaw Mountains, 22 June 1892, *Toumey 305a* (US); 16 km. south of Black River, White Mountains, about 1800 m. alt., 22 June 1930, *Goodman & Hitchcock 1297* (MBG, NY); Galiuro Mountains, 29 July 1894, *Toumey* (US); Tucson, 16 May 1896, *Zuck* (NY, US); washes, near Baboquivari Mountains, 24 Feb. 1923, *Hanson A1021* (F, MBG); Baboquivari Mountains, 10 March 1926, *Thackery & Leding 1100* (US); south of Warren, Sulphur Springs Valley, 3 June 1915, *Carlson* (US); Lowell, May 1884, *W. F. Parish 196, 197* (G); wash near Agua Caliente, 20 Jan. 1920, *Bartram 255* (ANSP).

CALIFORNIA: east side, summit of Providence Mountains, 29 May 1861, *Cooper* (US); vicinity of Bonanza King Mine, east slope of Providence Mountains, about 1200 m. alt., 21–24 May 1920, *Munz, Johnston & Harwood 4252* (P); Rock Spring, San Bernardino Co., May 1876, *Palmer* (G), *339* (F, MBG, NY, US); southern part of San Diego Co., 1875, *Palmer* (G).

MEXICO: LOWER CALIFORNIA: Piñone Forest, 25 July 1883, *Orcutt* (F).

In habit *V. Gooddingii* is much like *V. ciliata*, but differs in the villous-hirsute pubescence and the larger flowers. It is readily recognized in its typical form by the long-ciliate character of the bracts, the short dense villous spikes, and the shaggy pubescence.

47a. Var. **nepetifolia** Tidestrom, Proc. Biol. Soc. Wash. **38:** 15. 1925.

V. arizonica Briq. Ann. Conserv. & Jard. Bot. Genève **10:** 102. 1907, not *V. arizonica* Gray, Proc. Am. Acad. **19:** 95. 1883.

V. verna Nelson, Am. Jour. Bot. **18:** 436. 1931.

Leaves broadly ovate, coarsely and unevenly dentate, at times lobed, abruptly narrowed into a cuneate base; pubescence varying from strongly pilose to densely villous.

Distribution: Colorado, Nevada, Arizona, and northwest Mexico.

Specimens examined:

Colorado: southern Colorado, 1867, *Parry* (US).

Nevada: El Dorado Canyon, Lincoln Co., 1880, *T. W. Davis* (MBG); El Dorado at Nelson, 30 April 1907, *Jones* (P).

Arizona: Oatman, 4 May 1928, *Thackery 348* (US); Hackberry, 7 March 1912, *Wooton* (US); Camp Verde to Prescott, Aug. 1896, *Fernow* (US); by streams of Santa Catalina Mountains, 13 April 1881, *Pringle* in part (F, G, MBG); Tucson, 1871–5, *Rothrock* (US); Tucson, 1881, *Vasey* (US); Tucson Mountain, 7 March 1901, *Griffiths 2421* (NY); Tucson Mountain, 13 March–23 April 1903, *Griffiths 3489* (MBG, US); Laboratory Hill, vicinity of Tucson, April 1908, *Rose 11968* (US); Tucson, 1909, *Parish* (P); vicinity of Tucson, 1910, *Rose, Standley & Russell 15176, 15181* (NY, US); Tucson, 1911, *Beard* (MBG); Tucson Mountain, April 11, 1913, *Greenman & Greenman 56* (MBG); Tumanoc Hill, Tucson, 25 July 1916, *J. A. Harris C16375* (NY); rocky slopes west of Tucson, 26 Dec. 1919, *Bartram 257* (ANSP, US); near Tucson, 17 March 1927, *Harrison & Kearney 3646* (US); Sells, Papago Reservation, 24 Feb. 1926, *Loomis & Thackery 910* (US); Huachuca Mountains, Aug. 1882, *Lemmon* (US); south Huachuca Mountains, 31 May 1930, *Peebles 6755* (NY); Yucca, 14 May 1884, *Jones 3901* (F, P, US), type collection of *V. arizonica* Briq., *36* (G).

Mexico:

Lower California: Piñone Forest, 6 Oct. 1882, *Orcutt* (US); San Jacinto, 18 July 1885, *Orcutt 1303* (F, MBG, NY); Rosario, 3 May 1886, *Orcutt 5141* (F, MBG, NY); Agua Dulce, 48 km. southeast of San Fernando, 9 Sept. 1905, *Nelson & Goldman 7123a* (MBG, US).

Sonora: "Niggerhead Mountains, near Monument no. 82," Aug. 1893, *Mearns 1904, 1914* (US); Alamos, 26 March–18 April 1890, *Palmer 307* (G, US); Alamos, 27 Jan. 1899, *Goldman 292* (G, NY, US); Sierra de Alamos, 14 March 1910, *Rose, Standley & Russell 12840* (NY, US); Alamo, West Magdalena, 17 May 1925, *Kennedy 7033* (US); Pinocate Mountains, 21 Nov. 1907, *MacDougal 73* (US); La Cienega, 18 July 1911, *Goodding 952* (US).

Sinaloa: without locality, 1922, *Ortega 4541* (US); sandy soil along river, vicinity of Fuerte, 25 March 1910, *Rose, Standley & Russell 13449* (NY, US).

The variety differs from the species in its much less indented and broader leaves. The pubescence is much more variable and at times harsh, suggesting an intergradation with *V. bipinnatifida*.

The leaf-forms recall *V. canadensis,* but the spike is scarcely distinguishable from *V. Gooddingii.*

48. V. pumila Rydb. in Small, Fl. Southeast. U. S. ed. 1, 1010. 1903, and ed. 2, 1913.

V. inconspicua Greene, Pittonia **5**: 137. 1903.

V. brevibracteata Eggert, Torreya **2**: 124. 1902, not *V. bracteosa* var. *brevibracteata* Gray, Syn. Fl. N. Am. 2^1: 336. 1878.

Stems usually several from a common base, branched, decumbent-ascending, hirsute, often finely glandular; leaves 1.5–3 cm. long, obtusely triangular with cuneate or truncate base contracted into a short narrowly margined petiole, trifid, occasionally lobed, divisions variously incised, appressed-hirsute on both surfaces; spikes short-peduncled to sessile, fairly compact; bracts almost as long as the calyx, linear-lanceolate, hispid-hirsute; fruiting calyx about 6 mm. long, pubescent, hispidulous along the nerves, at times finely glandular, lobes subulate, short; corolla-tube a little longer than the calyx, slightly, if at all, pubescent without; corolla-limb 3–5 mm. broad; anther-glands minute or wanting; nutlets 2.5(–3) mm. long, reticulate-scrobiculate except at base; commissural faces muriculate.

Distribution: Oklahoma, Texas, New Mexico; and Sonora and Sinaloa, Mexico.

Specimens examined:

Oklahoma: Catoosa, 8 May 1895, *Bush 1275* (MBG, NY type); Oklahoma City, 11 May 1891, *Carleton 134* (US); vicinity of Fort Sill, 6 May 1916, *Clemens 11752* (MBG); Arbuckle Mountains, Davis, 1 April 1916, *Emig 401* (MBG); Price's Falls, Murray Co., 30 April 1926, *Stratton 11* (MBG); near Crusher Spur, Murray Co., 12 April 1913, *Stevens 28* (G, MBG, NY, US); near Tishomingo, 15 April 1916, *Houghton 2570* (G).

Texas: indefinite data, *Lindheimer 501* (F, G, MBG, US); Dallas, 17 March 1876, *Reverchon 738* (MBG, US), *1963* (F, G, MBG, NY), *2117* (MBG); Polytechnic, 10 April 1913, *Ruth 110* (MBG); Tarrant Co., 10 June 1913, *Ruth 110* (G); Haskell, 1898, *Morton* (MBG); sandy ground, near Granbury, Hood Co., 6 May 1900, *Eggert* (MBG); sandy ground, Big Spring, Howard Co., 11 June 1900, *Eggert* (MBG); Round Top Mountain, Comanche Co., 9 May 1900, *Eggert* (MBG); near Comanche, 10 May 1900, *Eggert* (G, MBG); San Saba River, Brady, 16 April 1926, *Studhalter 1106* (US); San Saba, 8 May 1917, *E. J. Palmer 11843* (MBG); plains west of Pecos, 20 April 1902, *Tracy & Earle 106* (F, G, MBG, US); foothills, Davis Mountains, 23 April 1902, *Tracy & Earle 178* (F, G, MBG, NY, US); sandy ground, near Bastrop, 17 April 1929, *E. J. Palmer 33367* (MBG, NY); dry hills, Austin, May 1872, *Hall 428* (G), *431* (MBG, NY, P); Austin, *Bray 98* (NY), *Young* (G, MBG), *Young 114* (P), *E. J. Palmer 9339* (MBG), *Tharp 1362, 1364* (US), *Armer 5381* (US); gravel bars of Blanco River, Blanco, 5 April 1918, *E. J. Palmer 13281*

(MBG); Big Branch, Gillespie Co., *Jermy 184* (MBG); New Braunfels, March 1850, *Lindheimer 434* (MBG), *1075* (F, G, MBG, NY, US); Lacey's Ranch, Kerr Co., 1 June 1916, *E. J. Palmer 10003* (MBG); Kerrville, 28 March 1916, *E. J. Palmer 9278* (MBG); Hungerford, 4 March 1914, *E. J. Palmer 4840* (MBG); Wharton, 18 March 1914, *E. J. Palmer 4977* (MBG); Bexar Co., *Jermy* (MBG), *84, 85*, (US); San Antonio, March 1882, *Havard* (US); San Antonio, *Jermy* (NY), *Jermy 209* (G), *Wilkinson 8, 108* (MBG), *Trelease 99* (MBG), *Eggert* (MBG), *Bush 1185* (MBG), *Clemens & Clemens 976* (MBG, P); Rock Springs, 17 April 1930, *Jones 26220, 26228* (P); gravel and sand bars, small streams, Uvalde, 11 May 1918, *E. J. Palmer 13562* (MBG); near Victoria, 11 April 1900, *Eggert* (G, MBG); Riverside, Walker Co., 24 March 1918, *E. J. Palmer 13175* (MBG); Brownsville, 23 Jan. 1919, *Hanson* (MBG); Brownsville, 30 Jan. 1919, *Hanson 322* (G, NY, US); Brownsville, 14–15 March 1923, *Tharp 1871* (US); southwest Texas, 1851–2, *Wright 1500* (ANSP, F, G, MBG, NY).

New Mexico: without data, 1851–2, *Wright 1501* (ANSP); Carlsbad Cavern, 5 May 1924, *Lee 109* (US).

Mexico:

Sonora: Alamos, 26 March–8 April 1890, *Palmer 326* (G); along an arroyo, vicinity of Alamos, 13 March 1910, *Rose, Standley & Russell 12745* in part (NY, US).

Sinaloa: San Blas, 2 Feb. 1927, *Jones 23243* (MBG).

Verbena pumila has often been confused with *V. quadrangulata* and, superficially, closely resembles it, but is readily separated on the beakless nutlets.

49. V. setacea Perry,[29] n. sp. Pl. 15.

Stems decumbent-ascending, soft-pubescent; leaves 3–5 cm. long, with cuneate-truncate base narrowed into a margined petiole, trifid with segments coarsely dentate, lateral lobes small, veins somewhat prominent beneath, soft-villous-pubescent on both surfaces; spikes short-peduncled; bracts linear-lanceolate, about three-fourths as long as the calyx, subulate-setaceous, soft-pubescent, ciliate; calyx 6 mm. long, villous-pubescent, teeth (2 mm.) about half as long as the tube, subulate-setaceous; corolla-tube 7 mm. long, pubescent without; corolla-limb about 6–7 mm. broad; anthers not glandular; mature nutlet not seen.

[29] **V. setacea** Perry, spec. nov., herbacea vel basi suffruticosa; caulibus decumbentibus ramosis ramis ascendentibus piloso-pubescentibus; foliis basi cuneata in petiolum alatum attenuatis 3–5 cm. longis trifidis segmentis grosse dentatis lateralibus parvis subtus venoso-reticulatis utrinque molliter villoso-pubescentibus; spicis breviter pedunculatis; bracteis lineari-lanceolatis subulato-setaceis piloso-pubescentibus ciliatis calyce paulo brevioribus; calyce 6 mm. longo villoso-pubescente, calycis dentibus subulato-setaceis 2 mm. longis; corollae tubo 7 mm. longo extus pubescente; limbo fere 6–7 mm. lato; connectivo antherarum superiorum inappendiculato; fructu immaturo.—Collected at Calmalli, Lower California, Jan.–March 1898, *Purpus 195* (P), type.

Distribution: Lower California.
Specimens examined:
MEXICO: LOWER CALIFORNIA: rocks, Calmalli, Jan.–March 1898, *Purpus 195* (P TYPE).

The gross habit of this plant is very like that of *V. Gooddingii* var. *nepetifolia.* Unfortunately the inflorescence is immature and only a few flowers are in anthesis, hence it is rather difficult to say what are the characters of the spike or of the mature nutlets. Moreover, the corolla may be larger than appears in this specimen. The flower itself is similar to that of *V. lilacina,* but the two plants are so different in habit it would seem as if this were perhaps only a superficial resemblance. The species is readily distinguished by its general habit and the long setaceous calyx-teeth.

50. **V. lilacina** Greene, Bull. Calif. Acad. Sci. 1: 210. 1885.

Stems erect, much branched, 0.5–1 m. high, very sparsely hirsute or glabrous except just below the spike; leaves 3–5 cm. long, contracted at base into a margined petiole, bipinnatifid (upper pinnatifid), divisions remote, ultimate lobes chiefly linear and acute, somewhat scabrous and strigillose on both surfaces, rugose above, midrib prominent beneath; spikes fascicle-like, cymosely arranged, long-pedunculate, bracts somewhat shorter than the calyx, lanceolate-setaceous, pubescent, ciliate; calyx about 7 mm. long, appressed-pubescent, short-hirsute along the nerves, lobes unusually long (2.5–3 mm.), attenuate into subulate-setaceous teeth; corolla-tube protruding very little beyond the calyx; corolla-limb 10 mm. broad, segments emarginate; anthers not glandular; nutlets almost smooth, slightly enlarged at the base; commissural face muricate-scabrous, not reaching the tip of the nutlet.

Distribution: Known only from Cedros Island.
Specimens examined:
MEXICO:
LOWER CALIFORNIA: Cedros Island: 29 April 1885, *Greene* (G); *1889, Palmer* (G), *677* (F, NY); March–June 1897, *Anthony 288* (F, G, MBG, US); 12 March 1911, *Rose 16155* (NY, US).

This is an anomalous species of uncertain relationship. It has an erect open habit with more or less glabrous stem and long internodes somewhat suggesting *V. neomexicana* (§ *Verbenaca*);

nevertheless, the short stout dense spike does not point to an affinity with this section. Although the anthers are not glandular, the sterile style-lobe protrudes well beyond the stigmatic surface, and, in mature fruit, the style appears to have been inserted in a deep depression at the apex of the schizocarp; hence the species is regarded provisionally as a member of the section *Glandularia.*

51. V. amoena Paxton, Mag. Bot. **7**: 3, *pl.* 1840.

V. grandiflora Sesse & Mocino, Pl. N. Hispan. ed. 1, 6. 1887–90 [La Naturaleza, II. 1. App.].

Stem about 5 dm. tall, decumbent or ascending, retrorsely hispidulous; leaves 5–8 cm. long, bipinnatifid, with the lower part entire, forming a broadly margined subauriculate and semiamplexicaul base, divisions remote, linear-oblong, sparsely incised, appressed-pubescent above, hispidulous beneath with midrib and veins prominent; internodes 4–6 cm. long; spike terminal, fascicle-like in anthesis, pedunculate; bracts linear-lanceolate, subulate, pubescent; calyx about 10 mm. long, densely pubescent, particularly along the nerves, glandular, teeth slender, subulate; corolla-tube slightly longer than the calyx, pubescent without, particularly around the throat; corolla-limb about 9 mm. broad; anthers unappendaged; mature fruit not seen.

Distribution: Mexico.

Specimens examined:

Mexico:

Michoacan: Puruandiro, *Sesse & Mocino 99* (Herb. Bot. Gard. Madrid type, MBG phot.).

Mexico: hills, Lecheria, 5 July 1904, *Pringle 13434* (US).

This unique species is readily recognized by its coarse habit, together with its bipinnatifid, subauriculate and semiamplexicaul leaves. Although Paxton's description is not accurate, the specimen agrees well with his plate and with the photograph of *V. grandiflora.*

Doubtful or Little-Known Species

"Verbena erinoides Lam." This species has established itself in several places. It belongs to a South American species-

complex needing critical study to determine accurately its real identity.

V. GRANDIFLORA Ortega, Hort. Matr. Dec. 2. 1797. Although the description is inadequate for positive identification, the phrase "Semina saepius duo" would seem to indicate that the species does not belong to the genus *Verbena*.

V. REPENS Spreng. Erst. Nachtr. d. Beschrieb. d. Bot. Gart. Univ. Halle, 40, no. 51. 1801. The literature on this species is very vague. The plant described is said to be a native of Santo Domingo. According to Lamarck,[30] the vervain of Santo Domingo is a species of heliotrope.

V. TRIFIDA HBK. Nov. Gen. et Sp. **2**: 273, *pl. 134*. 1818. This is a true *Verbena*, but none of the specimens at hand agrees with the description; and the floral drawings are insufficient to reveal its affinities.

V. BARBATA Grah. Edinb. New Phil. Jour. 176. 1827. This is undoubtedly a member of the section *Verbenaca*, but the description is too meagre to identify it.

V. INCARNATA Raf. Atl. Jour. 154. 1832. Here again the description is too inadequate for specific identification.

V. DELICATULA Mart. & Zucc. in Otto & Dietr. Allg. Gartenzeit. **2**: 245. 1834. Unfortunately the essential characters, which would separate this species from its allies, are not clearly defined. The description is so much like that of *V. barbata* that the writer suspects that these two species are identical.

V. MATTHESII Turcz. Bull. Soc. Nat. Mosc. **36**^{2}: 196. 1863. In the group to which this species evidently belongs, the units are very closely related; hence without more specific definition the species is obscure.

V. PAUCIFOLIA Turcz. Bull. Soc. Nat. Mosc. **36**^{2}: 196. 1863. This may be *V. carolina*, although the leaves of the latter are somewhat broader; but until such time as the type may be studied it seems preferable to withhold any decision regarding it.

V. INTEGRIFOLIA Sesse & Mocino, Pl. Nov. Hispan. 6. 1887 [La Naturaleza, II. 1. App.]. No known Mexican species of *Verbena* has entire leaves.

[30] Lamarck, Encyc. 1, Suppl. 5: 469. 1817.

V. SCABRELLA Sesse & Mocino, *l. c.* Apparently this species does not belong to the genus, but anything further regarding its identity is unknown to the writer.

V. AUBLETIA var. LAMBERTI M. E. Jones, Contr. West. Bot. **12**: 72. 1908. This combination, nomenclatorially, belongs in synonymy under *V. canadensis.* Its entity is clearly with the section *Glandularia*, but with which species it should be associated is unknown.

LIST OF EXSICCATAE

The collectors' numbers are printed in *italics.* Unnumbered collections are indicated by a dash. The number in parenthesis is the species number used in this revision.

Abrams, L. R. — (22, 31); *2481* (22); *2574* (31); *3406* (7); *3787* (22); *9487* (31).
Abrams, L. R. & McGregor, E. A. *5* (22).
Adole, Bro. *22* (29).
Aguirre, R. T. *4* (5).
Aiton, G. B. *8467* (15).
Alden, Lieut. — (35).
Allard, H. A. *207* (31).
Anderson, I. W. — (16).
Anderson, J. P. — (15, 16).
Anderson E. S. & Woodson, R. E., Jr. *47* (17); *1577* (32).
Andrews, L. — (16).
Anect, Bro. *57* (20); *100, 143, 179* (41); *211* (20).
Anthony, A. W. *288* (50); *380* (4).
Antisell, T. *186* (41a).
Applegate, E. I. *2228* (22).
Armer, A. A. *5381* (48); *5385* (8).
Arsène, G. — (1, 5, 11, 46); *672* (16); *2798* (7); *3000* (11); *6129* (34); *9998* (7); *10626* (29); *11820* (32); *11831* (8); *11859* (2); *11982* (35); *12117* (32); *12242* (8); *12534* (2); *18399, 18407, 18543, 18593* (31); *18615* (41); *18634* (31); *18793* (41); *18885, 18961, 18964* (31).
Arsène & Agniel, *10242* (7); *10252* (43).
Arsène & Benedict, *15734* (31); *16306* (41); *16600, 16790* (31).
Arthur, J. C. *24* (17).
Ashe, W. W. — (17).
Bailey, V. *221, 258* (43a).
Bain, S. M. *328* (19); *444* (16).
Baker, C. F. — (15, 16, 17); *288, 564* (31); *565* (20); *920* (31); *2591* (6).
Baker, C. F., Earle, F. S. & Tracy, S. M. *531* (42).
Ball, C. R. — (31); *344* (8); *401* (40); *553* (31); *556* (15); *605* (24); *909* (40); *1171* (25); *1585* (19); *1675* (31).
Ball, J. — (31).
Ballard, C. A. — (16).
Barber, H. S. *106* (43).
Barkelew, F. E. *231* (4).
Barlow, B. — (16, 42).
Barrett, C. H. M. *13* (38).
Bartlett, A. H. *1122* (1).
Bartram, E. B. — (7); *255* (47); *256* (25); *257* (47a); *1021* (17).
Basile, Frère, *99* (7).
Bates, J. M. — (16, 19, 40).
Beard, A. — (47a).
Beattie, F. S. — (15, 16).
Beaumont — (32).
Bebb, M. S. — (31).
Beckwith, F. *48* (19); *138* (20); *772* (38).
Benke, H. C. *4566* (35); *5046* (43a); *5164* (19).
Berg, H. K. — (14).
Bergmann, L. S. — (31); *2335* (16); *2370* (31).
Berkley, E. E. *1304* (16).
Berlandier, J. *322* (8); *429*=?*1749* (40);

Chestnut, V. K. — (22).
Choussy, F. *36* (11).
Churchill, J. R. — (31).
Clark, J. A. *55* (31); *253* (16); *279* (31).
Clark, O. M. *4041* (29a); *4250* (27).
Clawson, A. B. *13923* (42).
Clemens, Mrs. J. — (22, 31); *11748* (19); *11749* (15); *11750a* (31); *11751* (40); *11752* (48).
Clemens, Mr. & Mrs. J. *969*, *970* (8); *971*, *972*, *973*, *974* (29a); *976* (48).
Clements, F. *2612* (31); *2776* (40).
Clements, F. E. & E. S. *9* (31).
Clifton, R. L. *3085* (40).
Clute, W. N. *93* (31).
Clokey, I. W. — (36); *1865* (11).
Collins, F. S. *45* (1); *53*, *266* (2); *267* (6); *268* (14); *269* (1).
Collins, J. F. — (15, 16).
Combs, R. *389* (14).
Congdon, J. W. — (23).
Conzatti, C. *4194* (29); *4207* (7); *4288* (29).
Cook, O. F. & Griggs, *148* (5).
Cooper, J. G. — (47).
Cooper, J. J. *5890* (5).
Cory, V. L. *664* (44).
Cotton, J. S. *621*, *1363* (31); *1396* (16).
Coues, E. & Palmer, Ed. *279* (16); *498* (47); *571* (26a).
Coulter, — (43).
Coville, F. V. & Funston, F. *953* (31).
Cowen, J. H. — (41).
Crandall, C. S. *2014* (16).
Crawford, D. L. — (22, 31).
Crawford, M. A. — (36a).
Croft, M. B. *78* (33).
Culbertson, J. W. *4210* (22).
Curtis, C. D. — (15).
Curtis, M. A. — (6).
Curtiss, A. H. — (6, 17, 32); *677* (6); *1955* (17); *1959* (32); *1963* in part (2, 37, 38); *4386*, *4765* (32); *5111* (14); *5706* (37); *6490* (3).
Cusick, W. C. *1967* (31).
Cuthbert, A. *267* (2); *268* (32); *358* (2).
Davidson, A. — (14).
Davis, J. *16* (19); *73*, *950* (15); *1202* (19); *1274a* (15); *1513* (19); *2414*, *2691* (31); *2791*, *2960*, *2962* (19); *3192* (16); *3227* (19); *3453* (15); *3565*, *3578* (16); *3587* (31); *3588* (17); *3589* (19); *3590* (16); *3591* (15); *3817* (16); *3852*, *4450* (15); *4552* (17); *4461*, *4487* (19); *4565* (15); *6370* (19); *8458* (15); *9039* (31); *9117* (15).
Davis, T. W. — (47a).
Day, M. A. *79*, *147* (15); *149* (16).
Deam, C. C. — (19); *86* (43); *1272* (31); *6180* (5); *13619*, *20357* (17); *20357a* (19).
Deam, Mrs. C. C. *1799* (32); *1831* (35).
Dean & Thomas, *4874* (16).
Deane, W. — (15).
Dehesa, M. P. *1551* (11).
Demaree, D. *3353*, *3371* (31); *3553* (19); *6411* (35); *7539* (25); *7685* (43a).
Dewart, F. W. *15*, *18* (15); *42* (17); *74* (35).
Deweys, Mrs. F. E. — (8).
Dewhurst, B. L. — (31).
Dixon, R. A. *473* (24); *561* (40).
Dodge, C. K. *154* (33).
Donnelly, L. L. — (40a).
Drummond, T. — (14, 24, 35); *253 bis* (24).
Drushel, J. A. — (32); *2762* (35); *2842* (24); *3659* (35); *4887* (31); *6351* (16).
Duges, A. — (7, 11); *496*, *496a* (43).
Dunkle, M. B. *1955* (23).
Duss, Père, *3470*, *4697* (1).
Dutton, D. L. — (16).
Eames, A. J. *12797* (19).
Eames, E. H. — (19); *8137* (31).
Eames, E. H. & McDaniels, L. H. *4870* (15).
Earle, F. S. *84* (40); *387* (27); *427*, *606*, (25); *619* (27); *638* (41).
Earle, F. S. & Baker, C. F. — (31, 32).
Earle, F. S. & E. S. *236* (41); *351* (31); *387* (27); *526* (40).
Earle, F. S. & Underwood, — (32).
Eastwood, A. — (23, 41); *25* (31); *41* (16); *90* (19); *6500* (23); *8468* (42).
Eaton, D. C. — (15, 16, 17).
Edwards, — (20).
Eggers, H. F. A. von, *1828* (6).
Eggert, H. — (6, 8, 15, 16, 17, 19, 24,

Greenman, J. M. & Greenman, M. T. *28* (25); *56* (47a).
Gregg, J. — (8, 29, 43); *11* (7); *26, 57* (43); *99* (29); *202* (34); *246* (29); *257* (43); *265, 276* (7); *355* (36a); *406* (7); *433* (31); *545* (29); *623* (31); *632* (43); *636* (31); *648* (43); *740* (29); *752* (34); *756* (43); *764* (5); *791* (29a); *823* (7); *1001* (11).
Griffith, F. *3456* (40).
Griffiths, D. *1595* (25); *1919* (41a); *2421* (47a); *3431* (26a); *3489* (47a); *4244* (41); *4757* (43) *4833* (40a); *5050* (19); *5190* (42); *5560* (31).
Griffiths & Hunter, *18* (31).
Griffiths, D. & Thornber, J. J. *159* (40a).
Grimes, E. M. *3716, 3738* (17); *3794* (15).
Groth, B. H. A. *16* (29a); *30* (40); *75* (8); *187* (24).
Guidroz, H. *3* (15).
Gurney, J. & Monell, J. T. — (40).
Hale, T. J. — (8, 15, 17, 19, 24, 35); *245* (8).
Hall, E. — (19, 31); *393* (31); *428* (48); *429* (25); *430* (29a); *431* (48); *432* (8); *433* (1); *434* (24); *435* (35).
Halsted, G. *175* (15).
Hammond, E. W. *322* (22).
Hansen, G. *964, 1823* (22); *2025* (5).
Hanson, H. C. — (48); *A146* (43b); *A147* (31); *A148* (20); *322* (48); *551* (42); *619* (25); *645* (26b).
Hanson, H. C. & E. E. *A1021* (47); *A1130* (26a).
Harger, E. B. — (16, 17).
Harper, R. M. *15* (40); *242* (14); *385* (17).
Harris, J. A. *C16375* (47a).
Harris, W. *9132* (2); *9937, 11808* (14); *11969* (1).
Harrison, G. J. *4778* (26a); *4897* (14).
Harrison, G. J. & Kearney, T. H. *3646* (47a); *5796* (26a); *6144* (11); *6689* (26a).
Harshberger, J. W. — (1, 2); *41* (46).
Hartman, C. V. *94* (11); *608* (26a); *880, 906* (40a).
Hartweg, T. *174* (28); *175* (7); *176* (43); *177* (29); *1924* (22).
Harvey, F. L. *61* (19); *62* (31); *1958* (19).
Harwood, R. D. — (42).
Havard, V. — (25, 27, 31, 33, 42, 44, 48); *97* (42); *197* (27).
Hayden, F. V. — (15, 16, 40); *10* (31).
Haynes, D. — (22).
Hedgcock, G. G. — (15, 16).
Heller, A. A. — (15, 31); *638* (19); *1388* (33); *1419* (8); *1732* (29a); *5785, 5919, 6778* (22); *14222* (16); *14290* (19); *14303* (31).
Heller, A. A. & E. G. *3536* (42).
Henderson, L. F. *4070* (31).
Herrick, C. L. *704* (42); *715* (26b).
Hertel, H. — (15).
Hexamer, A. C. & Maier, F. W. — (16, 17, 35).
Heyde, E. T. *120, 477, 530* (11); *610* (5).
Heyde, E. T. & Lux, E. *3018* (11); *3019* in part (5, 11); *4370* (5).
Hicks — (15).
High, M. M. *52* (8); *59* (43a); *75* (33).
Hilgard, E. — (8, 32).
Hillman, F. H. — (31).
Hitchcock, A. S. — (2, 14, 15, 16, 17, 32, 35); *269* (14); *393* (40); *790* (35); *791* (17); *972* (19); *1129* (31).
Hoffstetter, G. — (15).
Holgate, W. R. — (31).
Holm, T. — (15).
Holzinger, I. M. — (19, 26, 41a).
Hooker, L. H. *5999* (34).
Hough, W. *109* (43).
Houghton, H. W. *2570* (48); *3622* (17); *3643* (35); *3646* (17); *4000* (19); *4015* (15).
House, H. D. *875, 1363* (17); *3276* (32).
Howell, A. H. *64* (19); *111, 308* (40); *313, 362* (8).
Howell, T. *174* (22); *292* (16); *1249* (22).
Hoyeradt, L. H. — (17).
Humboldt, A. & Bonpland, A. — (11); *4063* (36); *4066* (12).
Hyams, M. E. — (32).
Jaeger, E. C. — (47).
Jermy, G. — (48); *84, 85* (48); *182* (29a); *183* (40); *184* (48); *203* (8); *209* (48).

Jesup, H. G. — (16).
Johnson, A. G. — (15, 16, 19, 35).
Johnston, E. L. *507* (16); *986* (41).
Johnston, I. M. — (14); *1320, 1608* (22).
Jones, M. E. — (7, 8, 11, 16, 19, 20, 22, 23, 25, 26a, 40, 40a, 42, 43b, 47, 47a); *36* (47a); *122* (41); *372* (25); *457* (42); *487, 523* (16); *554* (29); *634* (41); *686* (43); *1487* (16); *2598* (22); *3801* (43b); *3901* (47a); *5478* (31); *6026* (20); *8963* (16); *23243* (48); *23244* (43); *25006* (11); *25480* (43b); *26220* (48); *26221* (25); *26222, 26223* (29a); *26224* in part (26b); *26225, 26226* (29a); *26227* (43b); *26228* in part (40, 48); *26229* in part (8, 40); *26231* (43); *26232* (43b).
Jones, W. W. — (47); *180* (43b); *185* (41a); *344, 346* (26a).
Joor, J. F. — (8, 14, 15, 32).
Kammerer, A. L. *33* (42).
Katzenstein, O. — (32).
Keeler, H. D. — (14).
Kellerman, W. A. — (17); *5825* (11).
Kellogg, J. H. — (15, 16, 35); *496* (17); *498* (19); *1130* (17); *1131* (16); *1958* (35); *15276* (31); *15277* (15).
Kellogg, W. — (38).
Kelsey, J. A. *173* (16).
Kempton & Collins — (11).
Kendall, M. L. — (22).
Kennedy, G. G. — (15).
Kennedy, P. B. *7032* (31); *7033* (47a).
Kerber, E. *255* (43); *311* (5).
Killiam, O. L. *6933* (15).
Killip, E. P. *3510* (5).
King, H. — (17).
Kirn, A. J. *2139* (14).
Knause, O. — (15).
Knowlton, C. H. — (16).
Korthoff, I. — (3).
Kreager, F. O. *469* (16); *474* (31); *475* (19).
Krig, J. T. *3187* (14).
Kuntze, O. *424* (43); *2109* (5); *23444* (28); *23738* (46); *23811* (24).
Lane, W. C. — (15, 16).
Lang, H. A. *102* (14).
Langlois, A. B. — (1, 24, 40); *123* (24).
Lansing, O. E. — (16); *2805* (16); *2806* (15); *2810* (19); *2976, 3135* (17); *3164* (19); *3241, 3340* (16).
Laybourne, W. A. — (15).
Lea, M. C. — (6).
Lee, D. W. *109* (48).
Lehmann, F. C. *1603* (46).
Leiberg, J. B. *902* (31); *2630* (16).
Lemmon, J. G. — (28, 47, 47a); *2857* (26a); *3075* (11).
Leon, Frère — (6); *685* (14); *3910* (1).
Leon, Frère & Edmunds, Frère — (6); *8719* (14).
Leonard, E. C. *3939* (6).
Leonard, E. C. & Killip, E. P. *534* (17).
Leroy & Ruger — (31).
Letterman, G. W. — (8, 15, 17, 19, 24, 35, 40).
Lewton, F. L. *141* (34).
Liebmann, F. M. *11308* (46); *11313, 11314* (34); *11316* (46); *11318* (13); *11328, 11329, 11330* (46); *11335* (10).
Lighthipe, L. H. *599* (35).
Lindheimer, F. — (8, 14, 16, 24, 35); *145* (24); *146* (40); *154* (24); *155* (8); *195* (15); *232, 289* (40); *294* (29a); *307* (40); *434* (48); *500* (29a); *501* (48); *618* (14); *1072, 1073* (40); *1074* (29a); *1075* (48); *1076* (8); *1077* (14).
Lloyd, C. E. *448* (11).
Lloyd, F. E. *159* (43).
Lloyd, F. E. & Tracy, S. M. — (6); *20* (3); *22* (14).
Loomis, H. F. & Thackery, F. A. *910* (47a).
Louis-Marie, Père, *141* (16).
Lumholtz, C. *445, 446* (36a).
Lunell, J. — (16, 31).
Lyall, D. — (31).
Lyon, *6* (14).
Lyonnet, E. — (7); *173* (36).
Macbride, J. F. *200* (31); *304* (16).
Macbride, J. F. & Payson, E. B. *781* (7); *850* (23).
MacDaniels, L. H. *4873* (16).
MacDougal, D. T. *73* (47a); *153* (7); *249* (20); *286* (31); *317* (40); *566* (16); *603* (47).
MacElwee, A. *760* (17); *873* (6); *882* (15).

Nuttall, T. — (17, 40).
Oakes, W. — (6).
Oersted, A. S. *11322, 11324* (5).
Olney, S. T. — (16).
O'Neill, H. — (14); *986* (32); *6309* (37).
Orcutt, C. R. — (18, 31, 33, 47a); *909* (18); *1228* (31); *1301* (23); *1302* (14); *1303* (47a); *1546, 1549* (31); *2736* (2); *3321* (13); *3488* (11); *3551* (46); *3950* (12); *4045* (11); *4146* (46a); *5141* (47a); *5423* (10); *5542* (33); *5555* (25); *5657* (43a); *5717* (25); *5730* (33); *5792* (43a); *5867* (8); *6096* (41); *6111* (29a); *6172* (43b); *6184* (44); *6197* (41); *6235* (25).
Ortega, J. G. *4215* (7); *4541* (47a).
Osterhout, G. E. — (15, 16, 20, 41); *3165* (40).
Over, W. H. *2103* (40); *3177* (40); *14386* (19).
Overholts, L. O. — (15, 17).
Pace, L. *22* (8).
Pagel, L. E. *2208* (33).
Palmer, Edward — (17, 26a, 41, 47, 50); *25* (29); *35* (43); *39* (34); *47* (40); *51* (36a); *52* (26a); *74* (43); *78* (8); *79* (43); *82* (29a); *90* (34); *135* (28); *141* in part (5); *141* in part, *153, 191* (coll. of 1898) (7); *191* (coll. of 1906) (36a); *200* (28); *268* (7); *281* (43); *295* (36a); *303* (29); *307* (47a); *308* (7); *309* (22); *310* (23); *312* (26a); *326* (48); *339* (coll. of 1876) (47); *339* (coll. of 1896) (11); *339½* (26a); *341½* (23); *342* (22); *345* (43); *356* (7); *364* (11); *397* (14); *401* (43); *456* (28); *677* (50); *911* (28); *1040* (14); *1042* (7); *1043* (8); *1044* (29a); *1046* (33); *1047* (29); *1048* (31); *1050* (41); *1051* (34); *1052* (36a); *1156* (11); *2014a, 2019* (5); *2037* (10); *2038* (25); *2039* (33); *2040* (25); *2055* (43); *2057* (11); *2529a* (22); *2699* (31); *6433* (38).
Palmer, E. J. *197* (16); *198* (15, 16); *199* (19); *200* (17); *304* (35); *454* (31); *559* (35); *1085* (16); *1747* (33); *2980* (19); *2981* (17); *2996* (35); *3319* (17); *4229* (15); *4232* (17); *4840, 4977* (48); *5044* (8); *5185, 5407, 5682* (35); *5769* (17); *6106* (31); *6107* (19); *6510* (40); *7001, 7071, 7124* (35); *7369* (8); *7556* (24); *7821* (40); *8000* (15); *8045, 9098* (40); *9111* (8); *9183* (29a); *9278, 9339* (48); *9485* (8); *9559* (32); *10002* (29a); *10003* (48); *10037* (8); *10568* (16); *10692* (14); *11715* (8); *11843* (48); *11979* (35); *12001, 12038* (1); *12056* (35); *12496a* (31); *13175, 13281* (48); *13282* (25); *13283* (29a); *13512* (39); *13562* (48); *13563* (29a); *13564* (8); *13730* (25); *13861* (31); *14283* (35); *15262* (17); *24616* (35); *27209* (40); *27462* (14); *28738* (16); *29303* (2); *29333* (35); *29535* (29a); *29804* (35); *30523* (25); *30672* (42); *30791* (26b); *31117* (31); *31153* (41a); *31192* (41); *33319* (35); *33367* (48); *33389* (40); *33537* (25); *33583* (42); *33592* (33); *33604* (8); *33605, 33646* (29a); *34065* (26b); *34240* (41); *34766* (17); *35235* (32); *37627* (19).
Palmer, W. — (16).
Pammel, L. H. — (17, 19); *78* (16); *85* (19); *187* (22); *272, 1699* (17); *1806* (16).
Pammel, L. H. & Blackwood, R. E. *3589* (31); *3638* (16).
Parish, S. B. — (14, 47a); *2819* (22); *5338, 7149* (14); *10288* (31); *11590* (22).
Parish, W. F. *196, 197* (47).
Parish, S. B. & W. F. *969* (22); *1043* (14); *2171* (31); *11143* (14).
Parker, C. F. — (6, 17, 31).
Parlin, J. E. — (16).
Parry, C. C. — (47a); *157* (40).
Parry, C. C., Bigelow, J. M., Wright, C. & Schott, A. — (26b, 31, 40, 44).
Parry, C. C., & Lemmon, J. G. *342* (22).
Parry, C. C. & Palmer, E. *717* (7); *718, 719* in part (46a); *719* in part (43); *720* (36a); *722* (28).
Patterson, H. N. — (19).
Patzky, — (28).
Pease, A. S. & Long, B. *22350* (16).
Peck, M. E. *8702* (22).
Peebles, R. H. *5353* (43); *6755* (47a).

Peebles, R. H., Harrison, G. J. & Kearney, T. H. *3790* (26a); *4243* (31); *4549* (40).
Peirson, F. W. *3379* (7).
Penard, E. *348* (41).
Pennell, F. W. *4204*, *4332* (1); *5444* (40).
Perkins, J. R. *1024* (1); *102* (2).
Peterson, N. F. — (35).
Phelps, O. P. *799* (16); *800* (15).
Pilsbry, H. A. — (42).
Piper, C. V. *6160* (22).
Pitcher, — (35).
Pittier, H. *414* (29); *1909* (11).
Plank, E. N. — (19).
Plaskett, R. A. *142* (22).
Plummer, F. G. — (42).
Pollard, C. L. — (38); *1191* (14); *1312* (17).
Pollock, W. M. — (16).
Porter, T. C. — (6).
Price, S. F. — (15, 17).
Price, W. W. — (26a).
Pringle, C. G. — (11, 14, 25, 26a, 28, 40, 47a); *54* (28); *270* (26a); *1117* (43); *1599* (7); *1948* (10); *2228* (34); *2813* (11); *2927* (46); *3467* (41); *3551* (46a); *4180* (46); *4769* (12); *4784* (29); *4877* (5); *4892* (11); *5715* (7); *6539* (28); *6908* (36); *7590* (28); *7591* (43); *8534* (7); *9135* (28); *9312* (11); *9313* (43); *9529* in part (7, 11); *11091* (43); *11092* (36); *11093* (5); *11843* (34); *13157* (41); *13158* (43); *13159* (28); *13434* (51); *13597* (12); *13792* (46).
Purpus, C. A. *137* (46a); *195* (49); *467* (29); *1094* (26b); *1095* (43); *1433* (36); *3406* (13); *3407* (43); *4524* in part (31, 43); *4974* (36a); *5451* (10); *5515* (29); *6061* (47); *6413* (1).
Quaintance, A. L. — (14).
Rafinesque, C. S. — (31).
Randolph, L. F. & F. R. — (32); *52* (37); *474* (15); *587*, *645* (6); *688* (1); *1004* (3); *1012* (14).
Ravenel, H. W. — (15, 31, 32).
Read, A. D. — (14); *19* (20).
Reade, J. M. — (1).
Redfield, J. H. — (15, 16); *522* (19); *6430* (17).
Redfield, R. *4* (11).
Rehn, J. A. & Viereck, H. L. — (42).
Renson, C. *175* (11); *291* (5).
Reverchon, J. — (15, 19, 35, 40); *42* (8); *118* (25); *732* (8); *734* (15); *735* (19); *736* (31); *737* in part (25, 29a); *738* (48); *739* (40); *740* (35); *834* in part, *1953* (25); *1961* (29a); *1962* (40); *1963* (48); *2116* (31); *2117* (48); *2118*, *2532* (24); *2533* (35); *3902* (33); *3903* (29a); *3904*, *4314* (25).
Reynolds, M. C. — (32).
Rich, W. P. — (31).
Riddell, J. L. *1268* (8).
Ridgway, R. *2431* (19); *2831* (15).
Riehl, N. — (16); *9* (31); *135* (15); *196* (19); *456* (17).
Robinson, B. L. — (19); *26* (32); *94* (2); *113* (6); *127* (2); *134* (15); *153*, *196* (16); *559* (15); *572* (16).
Rojos, *44* (11).
Rolfs, P. H. — (31); *191* (32).
Rose, J. N. *1677* (11); *1763* (7); *2435*, *2769* (43); *11968* (47a); *16155* (50).
Rose, J. N. & Fitch, W. R. *17105* (40); *17106*, *17503* (31); *17504*, *17801* (41).
Rose, J. N., Fitch, W. R. & Parkhurst, *17717* (20).
Rose, J. N. & Hay, R. *5310* (12); *5488* (28); *5556* (36); *6049* (46); *6212* (29).
Rose & Hough, *4484* (46).
Rose, J. N. & Painter, J. H. *6431* (43); *7741* (29); *7742* (43); *7799* (7).
Rose, J. N., Painter, J. H. & Rose, J. S. *8382* (7); *8495* (28); *8496* (11); *8668* (36); *8753* (7); *8823* (46a); *8971* (29); *9077*, *9151* (5); *9162* (29); *9503* (43).
Rose, J. N. & Rose, J. S. *11398* (43).
Rose, J. N., Standley, P. C. & Russell, P. G. *12451*, *12934* (7); *12745* in part (48); *12840* (47a); *13130*, *13422*, *13447* (7); *13449*, *15176*, *15181* (47a).
Rothrock, J. F. — (47a).
Rovirosa, J. N. — (5).
von Rozynski, H. W. *13*, *17*, *135* (29a).
Ruano, J. M. *332*, *403* (5).
Rugel, F. — (15, 31, 32, 35); *121* (6); *127* (17); *156* (14); *305* (38).
Ruger, M. — (17, 31).

Velasco, L. V. *8848* (5); *8999* (11).
Victorin, M. *3124, 15750* (15).
Viereck, H. L. — (42).
Visher, S. S. — (15); *1507* (19); *2028* (31); *2132, 2177* (40); *2263* (15); *3359* (31); *4439* (16); *4450* (19).
Vreeland, F. K. *636* (20); *804* (43b).
Wagner, F. *974* (41a).
Wallace — (14).
Ward, L. F. — (6, 24, 31, 35, 40, 41); *11* (20); *256* (31).
Warner, S. R. *43* (24).
Watson, S. *823* (31).
Waugh, F. A. — (15); *168* (35).
Weatherby, C. A. *5076* (16).
Webb, R. J. *5441* (16).
Webber, H. J. — (16, 19).
White, M. *165* (40); *174* (16); *197* (40); *206* (31).
White, O. E. — (40).
Wiggins, I. W. & Gillespie, D. K. *3977* (23).
Wilcox, T. E. — (11, 26a, 28, 40a, 47).
Wilkinson, E. H. — (8, 26a, 43); *8* (48); *9* (40); *108* (48).
Williams, E. F. — (15, 16).
Williams, T. A. — (40).
Wilson, N. C. *99* (47).
Wilson, P. *161* (17).
Wislizenus, A. *150* (26a); *325* (29a); *483* (42); *525* (41).
Wislizenus, F. *280* (17); *282* (15); *284* (31); *285* (35); *1214* (6).
Wolf, C. B. *2890* (41).
Woodson, R. E. *198* (35).
Wooton, E. O. — (20, 25, 26, 26a, 27, 31, 41, 41a, 42, 43a, 47, 47a); *187* (27); *208* (20); *363* (41); *364* (42); *409* (31); *642* (41); *646* (26); *2831* (31); *2835* (41a); *2836* (31); *3849* (43b); *3852* (26b).
Wooton, E. O. & Standley, P. C. *3330* (31).
Worthen, G. C. — (5).
Wright, C. — (15, 42); *454* (31); *455* (39); *567* (31); *1496* (25); *1497* (26); *1498* (16); *?1498* (44); *1499* (31); *1500, 1501* in part (48); *1501* in part (44); *1502* (40); *1503* in part (39, 40a, 42); *1504* in part (40, 42); *3658* (6); *3659* (14).
Wurzlow, E. C. — (3, 5).
Young, H. A. — (17).
Young, J. P. *737* (38).
Young, M. S. — (8, 25, 27, 42, 48); *77* (8); *112* (26b, 29a); *114* (48); *662* (1); *1703* (26).
Zuck, M. — (43, 43b, 47).

INDEX TO SPECIES

New species, varieties, and combinations are printed in **bold face** type; synonyms, in *italics;* and previously published names, in ordinary type.

Explanation of Plate

PLATE 13

(Drawn by Josephine Darlington. Magnification: figs. 1–3, × 5; figs. 9–19. × approx. 30)

Verbena macrodonta Perry

From the type specimen, *Nelson & Goldman 7425*, in the Missouri Botanical Garden Herbarium.

Fig. 1. Flower.
Fig. 2. Stamen.
Fig. 3. Pistil; (a) sterile style-lobe, (b) stigmatic lobe.
Fig. 4. Nutlet; (a) lateral, (b) commissural, (c) dorsal surfaces.

V. Wrightii Gray

Fig. 5. Flower.
Fig. 6. Stamen; (a) gland-like appendage.
Fig. 7. Pistil; (a) sterile style-lobe, (b) stigmatic lobe.
Fig. 8. Nutlet; (a) lateral, (b) commissural, (c) dorsal surfaces.

V. macrodonta and *V. Wrightii* are members of the sections *Verbenaca* and *Glandularia* respectively. Here are illustrated the contrasting characters of the inflorescence in respect to (1) the size of the flowers, (2) the staminal appendage, (3) the sterile and the stigmatic lobes in relation to each other and (4) the commissural surfaces of the nutlets.

Fig. 9. Diagrammatic longitudinal section of the flower of *V. canadensis*, showing the anatropous ovule with axile placentation.

Figs. 10–17. Diagrammatic transverse sections through the flower of *V. canadensis* to illustrate briefly the development of the carpels. Figs. 12–17 are of the ovary alone.

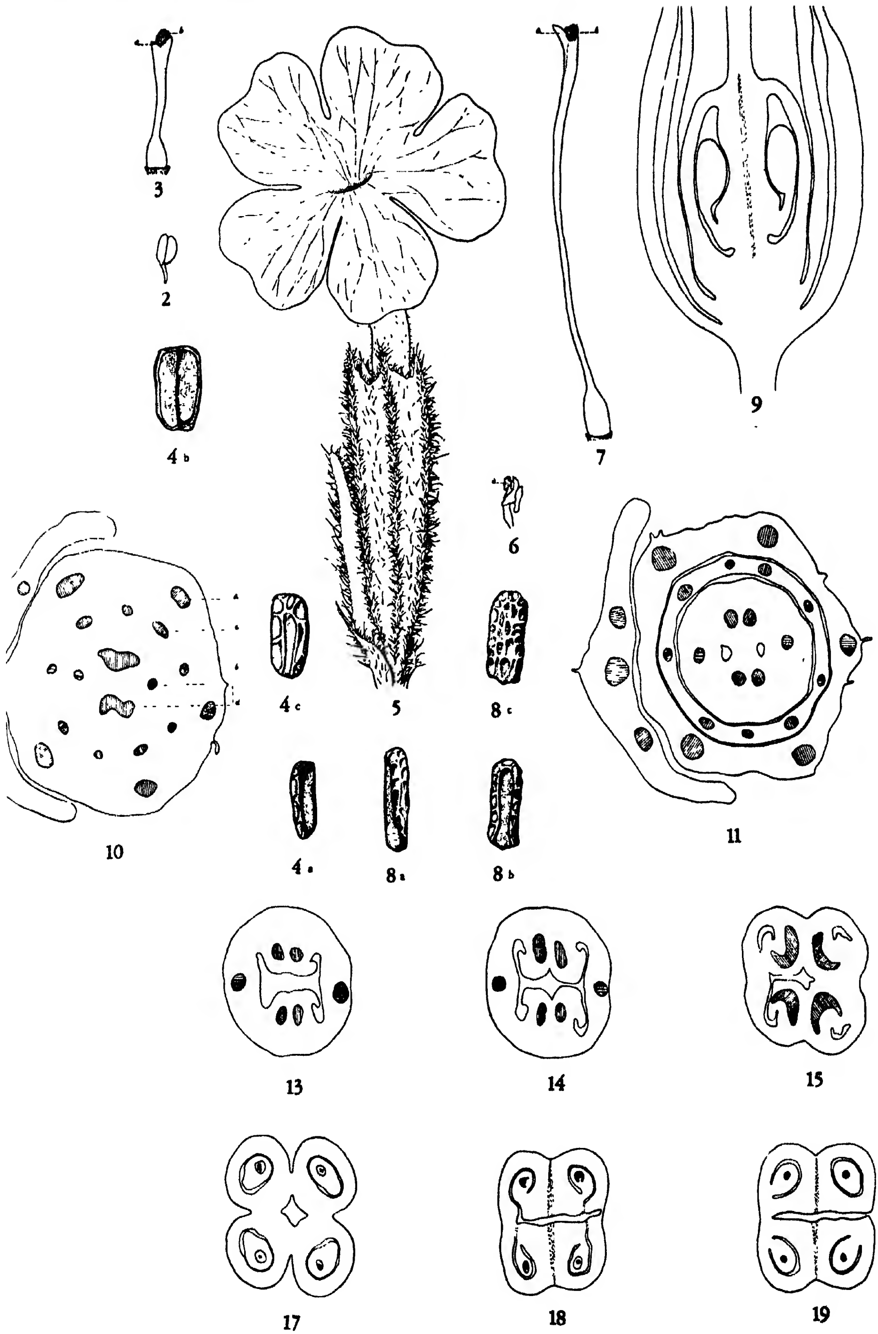
Fig. 10. Cross-section through the receptacle and the subtending bract after the central cylinder has broken up into (a) calycine, (b) corolline, (c) staminal and (d) carpellary traces.

Fig. 11. Showing the calyx and the corolla free from the ovary. In the latter, two breaks in the tissue have appeared. Probably these are the ontogenetic locules of a bicarpellary ovary.

Fig. 12. Showing the two locules united.

Figs. 13–17. Progressive steps in the development of the four ovules and their respective locules from the bicarpellary ovary. This is accomplished by the protrusion of the parietal placentae toward the centre bringing about axile placentation. Again the placentae appear to turn outward completing the development of the locules.

Figs. 18–19. Transverse sections of *V. bracteata*, demonstrating the subtrigonous form of the schizocarp in the section *Verbenaca* as contrasted with the subcylindric form of the schizocarp in the section *Glandularia*, cf. figs. 16 and 17.



PERRY—NORTH AMERICAN SPECIES OF VERBENA

Explanation of Plate

PLATE 14

Verbena macrodonta Perry. From the type specimen, *Nelson & Goldman 7425*, in the Missouri Botanical Garden Herbarium.

PERRY—NORTH AMERICAN SPECIES OF VERBENA

Explanation of Plate

PLATE 15

Verbena setacea Perry. From the type specimen, *Purpus 195*, in the Herbarium of Pomona College.

PERRY—NORTH AMERICAN SPECIES OF VERBENA

NUTRIENT SOLUTIONS FOR ORCHIDS

F. LYLE WYND

Assistant in the Henry Shaw School of Botany of Washington University

In a previous paper ('33) the author reported the result of growing seedlings of *Cattleya Trianae* Linden & Rchb. f., on three-salt solutions of various ratios, all having a total osmotic concentration of one atmosphere. It was found that the best growth was associated with solutions having low concentrations of phosphate ions. All other ions were varied between wide limits with but little apparent effect.

There is ample evidence in the literature of plant nutrition to support the belief that any set of nutrient salts at a given total concentration will exhibit more or less definite ratios for optimum growth, particularly if external conditions be kept constant. Since the effectiveness of any salt ratio depends upon the total concentration, it is not possible to compare the effects of specific ions in solutions differing in the total amount of salt present. The addition of extraneous ions may modify the permeability of the protoplasm and disturb the effectiveness of a given salt ratio. The solutions studied in the present work differ from each other in many respects, and the biological value of specific ions is therefore modified or obscured so that no comparison on the basis of ionic composition may be made. Such a comparison is possible only with the triangular series of salt ratios at a given total osmotic concentration.

In the previous paper, the nutrient solution of La Garde ('29) was cited as a very favorable medium for the germination and growth of orchids, but its effectiveness could not be attributed to the specific concentrations of the potassium or phosphate ions. The present study was carried out to test this further, and to ascertain which of several published nutrient solutions were most satisfactory for the germination of orchid seedlings.

The technique was the same as that described in the previous paper. The seeds were *Cattleya Trianae* Linden & Rchb. f. and from the same pod as those used for the triangular studies. The flasks were inoculated June 10, 1932, and the measurements were taken January 21, 1933. The molecular compositions of the solutions used are indicated in table I; their composition in parts

TABLE I

ON OF THE VARIOUS SOLUTIONS

Solution	$Ca_3(PO_4)_2$	$CaSO_4.2H_2O$	KNO_3	$MgSO_4.7H_2O$	$Ca(NO_3)_2.4H_2O$	KCl	KH_2PO_4	$CaCl_2$	$NaCl$	$(NH_4)_2SO_4$	K_2HPO_4	NH_4NO_3	$(NH_4)_2CO_3.H_2O$
La Garde ('29)				1 000	1.000		1 000	1.00				500	.500
Crone, in Benecke and Jost ('24)	.250	.500	1.000	.500									
Knudson ('22)				.250	1.000					.500	.250		
Sachs, in Benecke and Jost ('24)	.500	.500	1.000	.500					.500				
Pfeffer, in Duggar ('24)			.200	.200	.800	.100	.200						
Shive A ('15a)				3.698	.853		2 451						
Schimper, in MacDougal ('01)			.431	.431	1.724				.431		.431		
Shive B ('15b)				4.930	1.228		1.960						
Knop, in Benecke and Jost ('24)				.250	1.000	.120	.250						
Tottingham ('14)			.495	3.574	2.363		1.770						
Hansteen-Cranner, in Benecke and Jost ('24)				.615			.450	.56	.150	1.18			
Zinzadze ('26)	.077	.083		.170		.123						.066	

per million, in table II; and the growth data, in table III. All solutions received 1 cc. of a M/200 suspension of ferric phosphate per liter prepared as described by Livingston ('19).

TABLE II

COMPOSITION OF THE SOLUTIONS IN PARTS PER MILLION OF THE NUTRIENT COMPONENTS

	Ca	Mg	K	PO_4	SO_4	NO_3	NH_4	N (Total)	Cl
La Garde	360	98	287	698	390	388	283	308	658
Crone	213	49	387	153	474	623		140	
Knudson	169	25	112	137	462	525	137	225	
Sachs	310	49	387	307	474	623		140	302
Pfeffer	135	20	186	140	78	545		123	
Shive A	144	360	703	1710	1440	448		101	
Schimper	291	42	260	235	168	1071		241	260
Shive B	208	480	563	1368	1930	646		145	
Knop	169	25	134	175	98	525		118	58
Tottingham	399	347	700	1235	1390	1547		348	
Hansteen-Cranner	202	60	129	314	1098		322	250	458
Zinzadze	49	17	62	47	112	51	15	23	58

TABLE III

GROWTH DATA, BASED UPON THE AVERAGE OF 25 SEEDLINGS

Solution	Height in microns	Diameter in microns	% Total salt	pH at planting	pH at end of experiment
La Garde	4243	1590	.400	4.9	3.8
Crone	3760	1213	.225	5.5	4.5
Knudson	3360	1145	.200	5.0	4.5
Sachs	3258	1300	.300	5.1	4.5
Pfeffer	2953	1135	.150	5.0	4.6
Shive A	2908	1250	.700	4.8	4.5
Schimper	2835	1223	.345	5.1	4.5
Shive B	2793	1213	.812	4.8	4.4
Knop	2360	1145	.162	5.0	4.5
Tottingham	1868	900	.820	4.9	4.5
Hansteen-Cranner	No growth	No growth	.295	4.9	3.9
Zinzadze	No growth	No growth	.052	5.1	3.7

The fact that no growth occurred on the solution of Hansteen-Cranner and of Zinzadze was probably due to instability of the

pH of these solutions as shown by their high acidity at the end of the experiment. In this connection it is interesting to note that

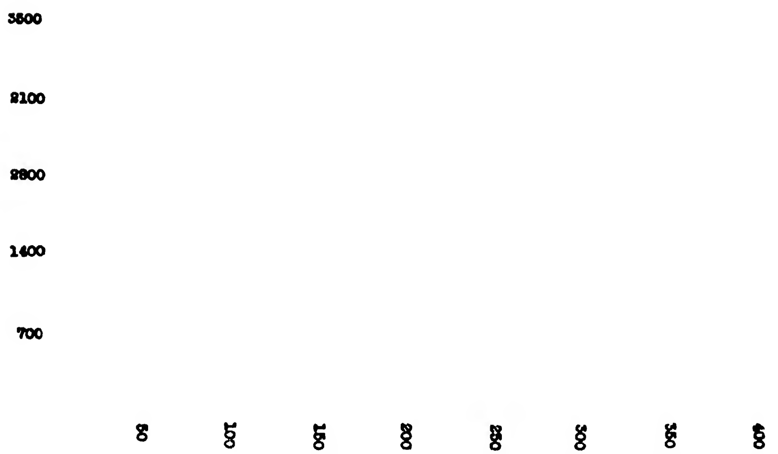


Fig. 1. The relation of growth to calcium content. Zinzadze, Pfeffer, Shive A, Knop, Knudson, Hansteen-Cranner, Shive B, Crone, Schimper, Sachs, La Garde, Tottingham.

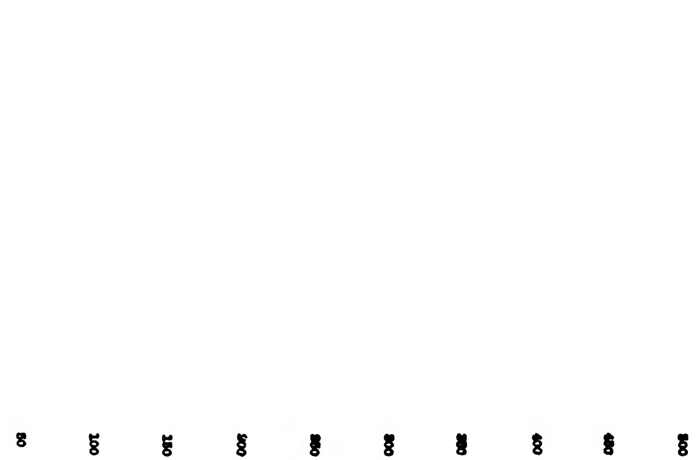


Fig. 2. The relation of growth to magnesium content. Zinzadze, Pfeffer, Knop, Knudson, Schimper, Sachs, Crone, Hansteen-Cranner, La Garde, Tottingham, Shive A, Shive B.

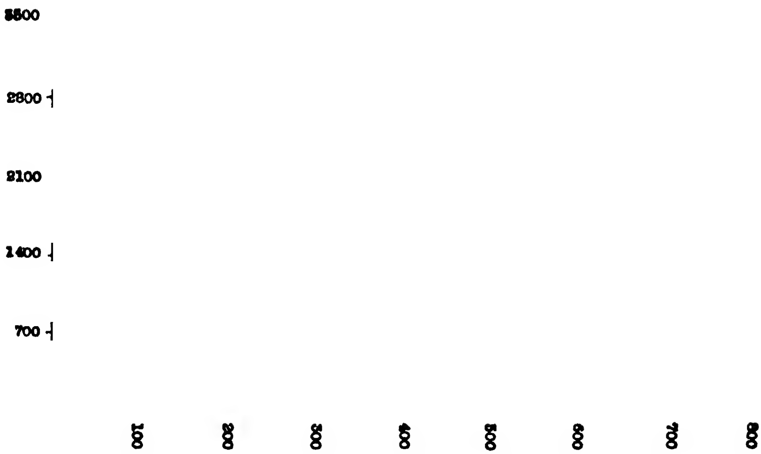


Fig. 3. The relation of growth to potassium. Zinzadze, Knudson, Hansteen-Cranner, Knop, Pfeffer, Schimper, La Garde, Sachs, Crone, Shive B, Tottingham, Shive A.

Fig. 4. The relation of growth to phosphate. Zinzadze, Knudson, Pfeffer, Crone, Knop, Schimper, Sachs, Hansteen-Cranner, La Garde, Tottingham, Shive B, Shive A.

Fig. 5. The relation of growth to sulphate. Pfeffer, Knop, Zinzadze, Schimper, La Garde, Knudson, Crone, Sachs, Hansteen-Cranner, Tottingham, Shive A, Shive B.

Fig. 6. The relation between growth and nitrate. Zinzadze, La Garde, Shive A, Knop, Knudson, Pffefer, Crone, Sachs, Shive B, Schimper, Tottingham.

La Garde's solution also was strongly acid at the end of the experiment, probably because of the greater growth of the numerous seedlings upon it. The use of ammonium carbonate by

La Garde was probably for its buffer action against this undesirable change of acidity with growth. The effectiveness of the concentration of carbonate used as a buffering agent was tested by preparing La Garde's solution with and without carbonate and then comparing the titration curves obtained with N/100 hydrochloric acid. In both cases, the titration curves were

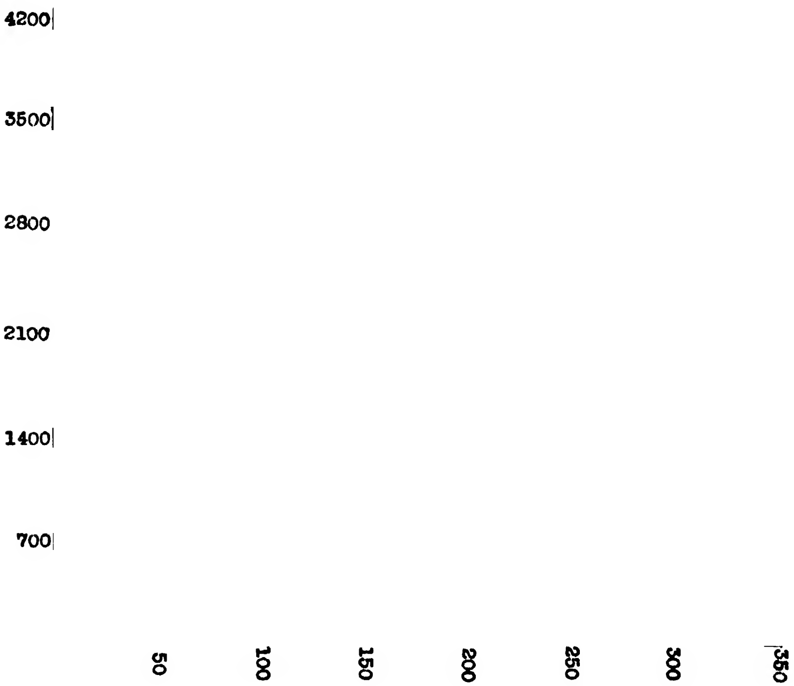


Fig. 7. Relation between growth and ammonia. Zinzadze, Knudson, La Garde, Hansteen-Cranner.

identical. The solutions were also analyzed for carbonate after autoclaving, but no positive test could be obtained. The autoclaving at 20 pounds pressure for 20 minutes at the initial pH necessary (4.25) undoubtedly destroyed the small amount of carbonate present.

Examination of table III shows that the best growth occurred on the solution of La Garde, followed by that on Crone's and

Knudson's. While the seedlings on La Garde's solution were conspicuously larger than those on Knudson's solution, the Knudson seedlings showed a definitely superior root development. The Crone seedlings were actually larger than those on Knudson's solution, but they did not appear to be so green. Of all the solutions tested, we would regard those of La Garde and Knudson to be the most satisfactory.

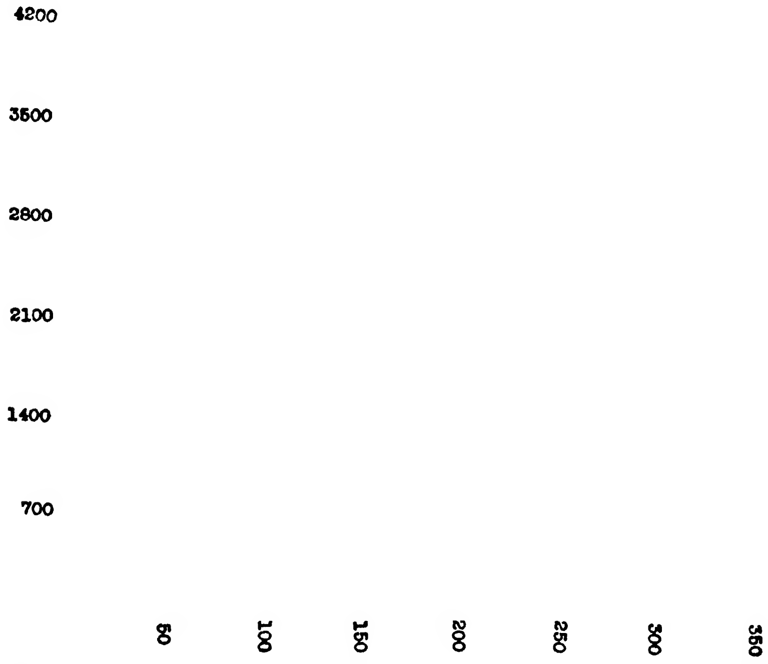


Fig. 8. Relation between growth and total nitrogen. Zinzadze, Shive A, Knop, Pfeffer, Crone, Sachs, Shive B, Knudson, Schimper, Hansteen-Cranner, La Garde, Tottingham.

The graphs indicate the comparative growth in relation to the concentrations in parts per million of each ion. It is apparent that the quality of the solutions is not related to a specific amount of any one ion. The author regards the superiority of La Garde's solution to be due to the particular complex of nutritional factors, and not to the specific effect of any particular ion. The nature of its superiority might well be a favorable condition of permeability of the cells produced by chemical means not yet understood.

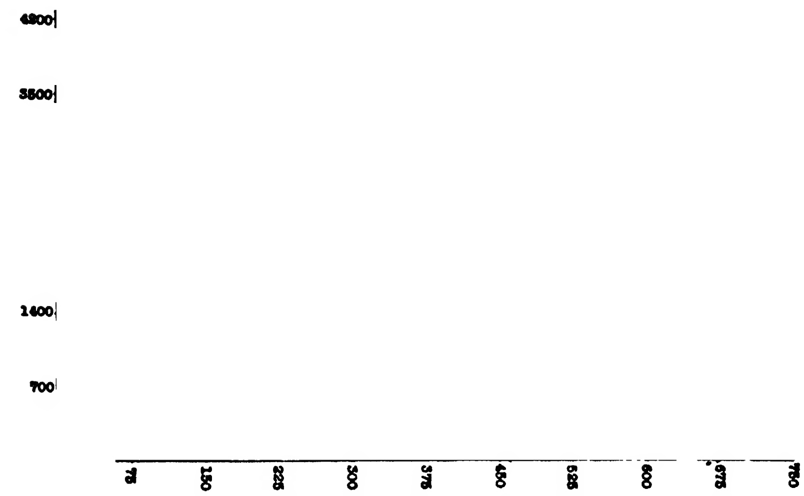


Fig. 9. Relation of growth to chlorine. Zinzadze, Knop, Schimper, Sachs, Hansteen-Cranner, La Garde.

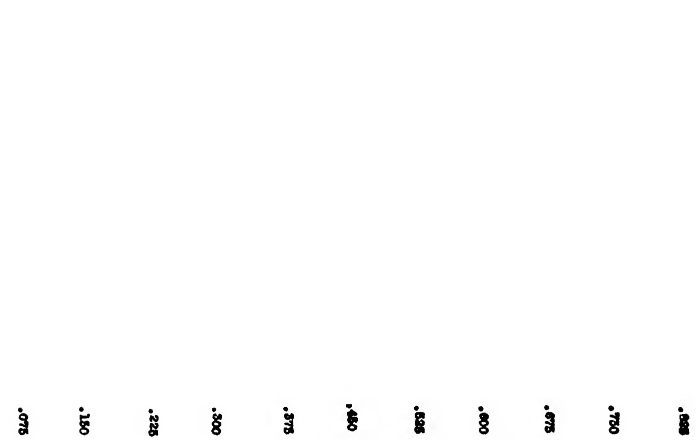


Fig. 10. Relation of growth to per cent total salt. Zinzadze, Pfeffer, Knop, Knudson, Crone, Hansteen-Cranner, Sachs, Schimper, La Garde, Shive A, Tottingham, Shive B.

In all figures, the vertical distance represents the height of the seedlings in microns, and the horizontal distance represents the

concentrations in parts per million of the ions indicated. The vertical lines representing the growth on the various media are listed from left to right.

Conclusions

1. Seeds of *Cattleya Trianae* Linden & Rchb. f., were germinated and grown on a number of published nutrient solutions. The best growth was obtained on La Garde's solution, which was closely followed by that obtained on the media of Crone and of Knudson.

2. No growth was obtained on the solutions of Hansteen-Cranner and Zinzadze. This was probably due to the unstable pH of these solutions.

3. The solutions studied differed in so many factors that the effects of any given species of ion were modified and obscured. Hence the nutritional value of the various solutions may not be interpreted as the effects of the concentrations of specific ions. This is clearly illustrated by the graphs.

The author wishes to thank Dr. E. S. Reynolds, Plant Physiologist, Missouri Botanical Garden, for his coöperation, and also Dr. G. T. Moore, Director of the Missouri Botanical Garden, for a generous supply of orchid seeds.

Bibliography

Benecke, W., and Jost, L. ('24). Pflanzenphysiologie **1**: 135–137. Jena, 1924.

Duggar, B. M. ('24). Plant physiology, p. 145. New York, 1924.

Knudson, L. ('22). Non-symbiotic germination of orchid seeds. Bot. Gaz. **73**: 1–25. 1922.

La Garde, R. V. ('29). Non-symbiotic germination of orchids. Ann. Mo. Bot. Gard. **16**: 499–514. 1929.

Livingston, B. E. ('19). A plan for coöperative research on the salt requirements of representative agricultural plants. Baltimore, 1919.

MacDougal, D. T. ('01). Plant physiology, p. 224. New York, 1901.

Shive, J. W. ('15a). A study of physiological balance in nutrient media. Physiol. Res. **1**: 327–397. 1915.

———, ('15b). A three salt nutrient solution for plants. Am. Jour. Bot. **2**: 157–160. 1915.

Tottingham, W. E. ('14). A quantitative chemical and physiological study of nutrient solutions for plant cultures. Physiol. Res. **1**: 133–245. 1914.

Wynd, F. L. ('33). The sensitivity of orchid seedlings to nutritional ions. Ann. Mo. Bot. Gard. **20**: 223–237. 1933.

Zinzadze, S. R. ('26). Eine neue Nährlösung. Ber. deut. bot. Ges. **44**: 461–470. 1926.

Annals
of the
Missouri Botanical Garden

Vol. 20 SEPTEMBER, 1933 No. 3

THE FOLIOSE AND FRUTICOSE LICHENS OF COSTA RICA. I

CARROLL WILLIAM DODGE

Mycologist to the Missouri Botanical Garden
Professor in the Henry Shaw School of Botany of Washington University

While there exists much literature on various groups of lichens from various parts of tropical America, at present I know of no recent work covering the whole area or that of any constituent country whereby the traveler may identify the lichens he meets, or the student in an herbarium of the temperate zone may readily determine any considerable portion of the miscellaneous material sent in by collectors. It is hoped that this work may furnish such a manual, although no one realizes better than I the huge amount of monographic work necessary before a book approaching completeness and accuracy can be published.

I first came under the spell of the rich flora of Costa Rica during a two-weeks visit in the summer of 1925 and at that time formed the resolution to spend my first sabbatical year in that country in the study of its fungus and lichen flora. During the subsequent years much material in addition to my own collections came to me for identification. Plans were matured and in early September, 1929, my family and I landed in Costa Rica and made our headquarters in San José, the capital of the country. In the latter part of September I was joined by Mr. W. Stephen Thomas, a student at Harvard, who accompanied me on most of the collecting trips until the middle of March. Mrs. Dodge also spent some time in the field and much is owed to her keen observation and helpful care of the collections. Even the small daughter, at the age of four, added a number of specimens

Issued October 6, 1933.

not otherwise easily obtained, through her skill in climbing guayabos (*Psidium guajave* L.) which were too small and too brittle to be climbed by an adult. We left Costa Rica in June, 1930, and after a brief stay at the Farlow Herbarium to sort over material and give tentative determinations I took the more puzzling specimens to Europe where the months from August to December, 1930, were spent in the larger herbaria.

Very many persons and institutions have contributed to the success of this undertaking both at home and abroad, and to all I tender my most hearty thanks in grateful acknowledgment of their many kindnesses. For financial assistance, I am grateful to the John Simon Guggenheim Memorial Foundation which appointed me as a Fellow to Costa Rica for the year 1929–30 and to Europe from October to December, 1930; to the President and Fellows of Harvard College and to the Farlow Herbarium, for equipment, incidental expenses, and for an assistant in the field; to my colleague, Prof. Greenman, and former colleagues, Professors Ames, Barbour, and Thaxter, and to Mr. Paul C. Standley of the Field Museum, for excellent advice in planning my trip and for helpful letters of introduction. Members of the staff of the United Fruit Company were also very helpful both in planning the trip and placing the facilities of that great company at my disposal in Costa Rica, especially Dr. J. R. Johnston of the Boston office, and Messrs. Kress, Fuller, Crawford, Stübbe, and George Catt, the director of its Botanical Garden and Experiment Station at Siquirres, who accompanied me on several trips in that vicinity.

Among Costa Ricans, I am deeply indebted to the following for advice and hospitality, without which I should have been unable to cover so much territory so thoroughly in so little time: Bernado Yglesias Rodriguez, the Director of the Escuela Nacional de Agricultura, who placed the facilities of the botanical laboratory at my disposal and enabled me to spend three very profitable weeks at the ancestral Yglesias finca, Guayabillos, on the upper slopes of the western face of Irazú; to Anastasio Alfaro, formerly director of the Museo Nacional (and later to his successor, the late J. Fidel Tristan), who placed the facilities of the library and herbarium (Wercklé) of the institution at my dis-

posal and suggested the plan of my trip to Guanacaste, as well as contributing several specimens; to Dr. Alberto M. Brenes, the botanist at the Museo Nacional, who collected extensively for me in the vicinity of San Ramón, an interesting region which I did not have an opportunity to visit personally; to Ricardo Chavarría Flores, formerly city engineer of Cartago, who enabled me to collect extensively at his finca in the vicinity of Santiago de Cartago and the Rio Birrís; Juvenal Valerio Rodriguez, of the Instituto de Alajuela, who planned trips in the vicinity of Alajuela and to the Cerros de Zurquí; Otón Jiménez Luthmer, of the Botica Oriental, a well-known amateur botanist, who gave generously of his time in suggesting trips and making plans, although his business duties prevented his accompanying me in the field except for a short time on our trip to Guanacaste; to Ferdinand Nevermann, the coleopterist, for numerous pleasant collecting trips, including a three-weeks stay at fincas of which he is manager in Limón Province, and for much helpful information in connection with my large insect collections; to Ruben Torres Rojas, of Cartago, for specimens, although I did not have the pleasure of a personal contact with him during my short visits to Cartago; and to Charles H. Lankester, for helpful suggestions. Besides these who are more or less professionally interested in natural history, the following were generous in their hospitality and enabled me to visit regions which would have been otherwise quite inaccessible to the traveler: Gonzalo Volio and his son Carlos, Antonio Sobrado and his brothers, Carlos Collado, Fernando Castro, José Castro Araya, Antonio Gutiérrez, José Luis Sancho, Carlos Piedra and son, Alexander Ross and sons, Robert Hanckel, and H. J. Marks.

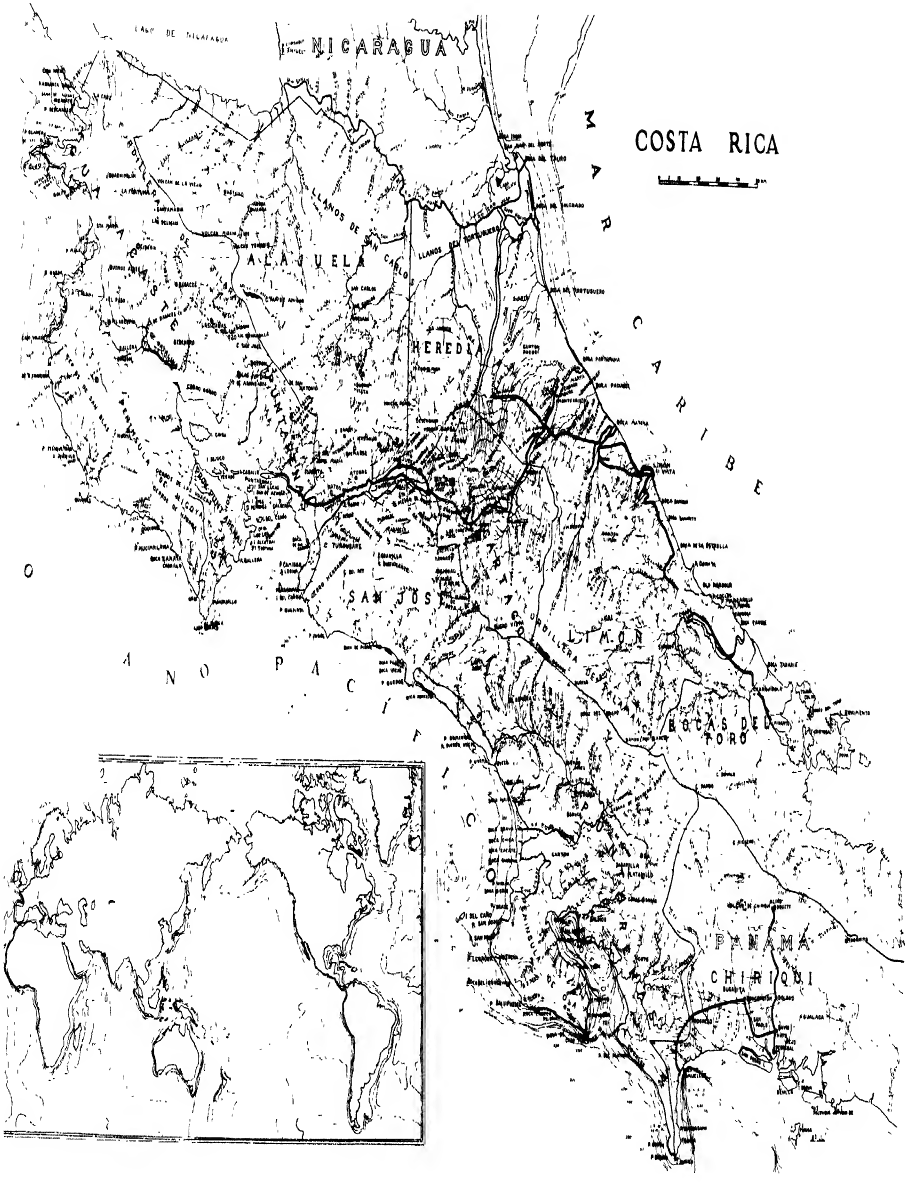
While in Europe I was indebted to the curators, acting curators, and staffs of the following institutions for permission to study the herbaria under their care: the Art Galleries of the Glasgow Corporation (Stirton Herbarium); British Museum of Natural History; Royal Botanic Gardens at Kew; Universitetets Botaniske Museum, Oslo; Botaniske Trädgård, Upsala; Riksmuseet, Stockholm; Botaniske Museum, København; K. Botanische Garten, Berlin-Dahlem; K. Botanische Museum, München; Conservatoire Botanique and Herbier Boissier of the Université

at Genève; and the Laboratoire de Cryptogamie at Paris, as well as the private herbarium of M. le docteur M. Bouly de Lesdain of Dunkerque. I am also indebted to the following lichenologists, whom I met during my trip, for helpful suggestions and criticism: Miss A. L. Smith, Bernt Lynge, Einar DuRietz, the late Karl Schulz-Korth, J. Motyka, and Ove Høeg. Since my return to America I have had access to or seen specimens from the following herbaria, for which I gratefully acknowledge my indebtedness to the curators: Farlow Herbarium of Harvard University, New York Botanical Garden, National Herbarium of the Smithsonian Institution, the Field Museum of Natural History, Chicago, the herbaria of the University of Michigan and of the Missouri Botanical Garden. I am also grateful to the Director of the Missouri Botanical Garden and to the Chancellor of Washington University for a leave of absence after the appointment to the staffs of those institutions, in order that I might complete certain studies in the Farlow Herbarium of Harvard University before I left that institution. Finally I wish to thank any others through whose hospitality and assistance this work has been made possible.

Geography

Topographically Costa Rica may be divided into four main phytogeographic regions: the Atlantic Coastal Plain, the Meseta Central, the Subalpine Region, and the Pacific Coastal Region, the latter less well known and less homogeneous.

The Atlantic Coastal Plain is characterized by its gentle slope from the sandy beaches up to about 100 m. or even higher in the poorly known Llanos de Santa Clara and in the Sarapiquí, San Carlos and Río Frío valleys. The beaches are interrupted only by shallow harbors at Cahuita, Limón, and Moin, the first being protected by a coral reef, the two latter being partially protected by the small island Uvita, now used as a quarantine station for Puerto Limón. Several large rivers rising in the highlands cross this plain and during their flood states overflow, forming spectacular anastomosing channels which leave small pools in the dry season. Most of the river mouths are closed by shifting bars which hinder or prevent the use of the rivers for



DODGE—LICHENS OF COSTA RICA

COCKAYNE, BOSTON

shipping. Just back of the beach there is an almost continuous series of lagoons, which may be dredged and may be used for transport of the farm produce to the railroads and ports. These lagoons extend most of the way from San Juan del Norte to Limón.

The soil is quite fertile where drainage is sufficient and much of the forest has been cleared for agricultural purposes, in the Llanos de Sta. Clara and Limón. The rainfall is heavy and quite evenly distributed, although somewhat less during January, February, and March, the so-called dry season (verano). During most of the year the sun shines until about noon, then showers may be expected for either a short time or for the rest of the afternoon. The nights are usually clear and cool.

During the colonial era there was very little permanent settlement of this region although many attempts were made. Some cacao plantations were developed at Matina, and their product taken overland via Cartago to Honduras and Guatemala or quietly sold to the English pirates and smugglers who frequently entered the mouth of the Matina River for this purpose. With the advent of the Northern Railroad in 1870–1890 the banana industry spread rapidly over most of the available land from the Parismina to the Estrella River valleys and up the Sixaola from Bocas del Toro. When the banana wilt or Panama disease (*Fusarium cubense* E. F. Smith) and increasing soil exhaustion began to threaten this industry, coconuts, pineapples, and cacao were extensively planted in suitable localities. Coconuts were a prompt and complete failure owing to bud rot and other factors, although they still furnish enough for local consumption. Pineapple cultivation has recently been abandoned for economic reasons, although the product was much superior to that of Hawaii. Cacao cultivation has been only partially successful owing to high labor costs. Recently much land has been practically abandoned and is gradually returning to second-growth forests. While small plantations of forest trees, as *Hevea*, *Ochroma*, etc., are still in an experimental stage, they seem to be successful botanically but owing to the high cost of labor they are still doubtful economically. Maize is sometimes grown on the Llanos de Santa Clara.

The Atlantic Coastal Plain penetrates far inland in the Tortuguero, Sarapiquí, San Carlos and Río Frío systems, but since I have not had an opportunity to examine them personally and have seen very few specimens from them it is impossible to discuss them further. Before the railroad was built the Río Sarapiquí was the main route from San José to the Atlantic, and a few villages still remain. There are a few scattered settlements on the Río San Carlos and Río Frío, as may be seen from the relations of Thiel and Cespedes, but except for a few specimens by Pittier from the upper Sarapiquí Valley and from the vicinity of San Rafael on the R. San Carlos, I know of no lichen collections from this region.

The Atlantic Transition Zone from 100 to 900 m. is evident mostly in narrow river valleys, the only botanically well-known portions being the southeastern portion of the Llanos de Santa Clara around Guápiles, formerly an important farm of the United Fruit Company used for their earlier experimental plantings of forest trees, and the valley of the Reventazón.

In the valley of the Reventazón, tertiary sedimentary rocks are evident in the cañons and railway cuts. The slopes are very steep, due to the great erosion caused by the heavy rainfall which is about the same as that of the Coastal Plain. Bananas and coffee form the principal crops in the broader side valleys, the banana being comparatively short-lived but much used as a shade for the coffee. Since this development is comparatively recent, it still remains to be seen whether this is a permanent stage or a temporary phase in the agricultural development of the region. Formerly sugar cane was extensively cultivated in this region and considerable areas remain in Juan Viñas and Santiago de Cartago. Pineapples are grown for the domestic markets near Turrialba and to a less extent in some other places. Owing to the rapid erosion it seems doubtful whether much of the land which has been cleared on such steep slopes can remain permanently in cultivation. There are available a few collections from Angostura near Turrialba by Polakowsky and my own from the beautiful valley of the Río Pejivalle near the United Fruit Company's farm of that name, as well as the even more extensive ones from Santiago de Cartago and occasional specimens from

Juan Viñas (Naranjo) by Ørsted and scattered numbers by Pittier.

On the practically inaccessible slopes and in the valleys where transportation is too costly to make farms economically profitable yet, some forests are still to be found. These still resemble those of the Atlantic Coastal Plain with their abundant epiphytes, bromeliads being conspicuous, especially *Tillandsia usneoides*. There are many small areas among the hills where fogs keep the humidity much higher than in neighboring areas. These are quite evident by the abundance of the long pendulous species of *Usnea* which replace *Tillandsia usneoides* as a prominent feature of the landscape. Species of *Leptogium*, *Parmelia*, *Anaptychia*, and mosses are also very abundant. Cladonias begin to appear and replace the similarly colored moss of the lower elevations. In the top of the forest trees and in the isolated trees of the potrero (pasture), crustose species are abundant. In the lower levels of the forest, lichens are rarer and usually sterile, perhaps due to the small amount of light. Trees whose bark scales off rapidly, such as the guayabo (*Psidium guajave* L.), are rarely found to have lichens, except for a few fruticose species of *Ramalina* and *Usnea*. *Nephroma* was found in one of these *Usnea-Tillandsia* zones on an exposed "knife-edge" protruding into the cañon of the Reventazón near Santiago de Cartago.

The Meseta Central, occupying the huge central valley between the Cordillera Central and the Cordillera de Talamanca, consists of long gentle slopes between 1000 and 1700 m. cut by deep river gorges. The pass of Ochomogo and the Cerro de Carpintera divide this meseta into two portions, the eastern valley of Guarco, comprising the upper portion of the valley of the Reventazón and its tributaries, and the western valley of San José, comprising the upper part of the valley of the Río Grande de Tarcoles and its tributaries. The valley of Guarco is bounded on the north by the upper slopes of the volcanoes Irazú and Turrialba and on the south by the continental divide in the Cordillera de Talamanca. Most of the large tributaries enter from the south and are not explored fully from a geographical standpoint. I have seen lichen collections from the valley of the Río Navarro and the

lower part of the Orosí. The Río Grande is by far the largest and longest of the tributaries but its flora is wholly unknown to me. Coffee is the principal crop though considerable amounts of garden vegetables, especially chayote and yuca, are raised to supply not only the local markets but also the demands of the Atlantic Coastal Plain. Cartago, the colonial capital, is the only city but there are numerous small towns. The collections of C. Wercklé, "near Cartago 1200–1500 m.," in San José and Berlin, seem to be from the region about Aguacaliente and the lower slopes of the Cerro de Carpintera, judging from species represented.

The valley of San José is bounded on the north by the continental divide of the western portion of the Cordillera Central, the volcano Poás, and Barba with its lesser peaks, the Cerros de las Caricias, Las Lajas, and Zurquí, on the east by Irazú and the Cerro de Carpintera, on the south by the Cerros de Escasú and Piedra Blanca, on the west by the Cerros de Aguacate. In the valley of San José the slopes descend gently to about 650 m. This valley is much drier than the Guarco with a longer dry season from December to April and less rain in the other months. The winds are strong, especially in the dry season. Practically the whole region has been denuded of forests, partly in the interests of agriculture and partly owing to the fiendish glee of the inhabitants who deliberately set fires to the dry grass on windy days in order to watch it burn. By the end of the dry season practically the whole valley outside the cafetales and cane fields is black from the charred remains of grass fires.

The underlying rock of both valleys is largely volcanic, while the soil above is largely of aeolian origin from the volcanic dust which is still being regularly emitted from Irazú and occasionally from Poás. In some places fields of volcanic boulders exist in such profusion that they make agriculture as difficult as do the glacial boulders in parts of New England. The greater portion of both valleys is devoted to coffee growing, with sugar cane and upland rice in the lower levels. Formerly considerable excellent tobacco was grown but this crop has practically disappeared. The cities of Alajuela, Heredia, and San José, and many important towns are located in this valley.

Crustose lichens are abundant in the cafetales both on the coffee and its shade, but practically no attempt was made to collect them since the thalli are mostly young and sterile and we hesitated to injure the trees by removing portions of bark. The living fence posts, mostly species of *Erythrina* (poró), were utilized, however, since they are regularly and heavily pruned back. These yielded most of the crustose species from this area. Another fruitful source was the roadside bank. These banks are caused by erosion and by cutting down with spades to secure material to fill in holes in the road. The depth of a road in most places is proportional to the slope and to its age, a recently laid-out road having only slight banks while an old road often has vertical sides rising 15–30 feet above the wheel tracks. These banks have a wealth of lichens, bryophytes, and fungi during the rainy season (invierno) but usually dry out, except in occasional moist shady spots, during the dry season. Consequently most of the species are annuals and disappear quite completely during the dry season. These banks are even more conspicuous and important in the Subalpine Region.

The Subalpine Region probably includes most of the land in Costa Rica above 1700 m., but is known botanically only on the Cordillera Central and the northernmost mountains of the Cordillera de Talamanca as far as the Cerro de las Vueltas. Poás, Irazú, and Turrialba are largely cleared on their southern slopes and used for dairy farms. Barba is still largely wooded and inaccessible, but Standley and Maxon have explored the slopes of the lower peaks of the Cerros de las Caricias, las Lajas, and Zurquí. I also had the opportunity to spend two days on the lower slopes of Zurquí. Standley and J. Valerio secured an extensive series of lichens from Cerro de las Vueltas and neighboring peaks within reach of Santa María de Dota, in 1925–6. Various collectors have brought back small series of specimens from Poás. Standley in 1924 and I in 1929 collected on the south slope of Turrialba for a short period, and I spent about three weeks at Guayabillos on the west slope of Irazú, as well as climbing to the crater twice from the south side. Ever since the time of Ørsted many collectors have brought in a few specimens from Irazú. The alpine and subalpine areas of Irazú

are much less rich than the other mountains probably because of the constant dust. On my last ascent I did not find even a sterile thallus above 3000 m., while Ørsted reports lichens from the summit. Botanically this Subalpine Region is the most interesting, as it has a high percentage of Colombian and other South American species, as well as most of the endemic species.

The Pacific Coastal flora is too poorly known to classify into geographical divisions. I have been told by lumbermen that there are many interesting local distributions of the forest trees but these observations are too fragmentary for generalizations. For present purposes we may subdivide into the province of Guanacaste the peninsula of Nicoya, the great river valleys of the R. Naranjo, R. General, and R. Grande de Térraba or Diquís, and the Peninsula of Osa. Of these regions I have personally visited only the first and the last. The peninsula of Nicoya has not been explored at all as far as concerns lichens, while our knowledge of the great river valleys is due solely to two journeys by Pittier, Biolley, and Tonduz, in January and February, 1891, and by Tonduz from October 18, 1891, to April 17, 1892 (see p. 388).

The province of Guanacaste consists of a low coast range penetrated by the Bahías de Culebra and de Salinas, a broad valley of the R. Tempisque about 40 km. wide and 60 km. long, rising gently from sea level to about 200 m. and sloping again gently to the Lago de Nicaragua, with Liberia, the provincial capital, at its center, and the west slope of the Cordillera de Tilarán (or de Guanacaste) on its east. Ørsted crossed the plain from the Tempisque to the Bahía de Salinas and explored the region of R. Sapoa and the coast, but I have seen no lichens from this region. Pittier collected along the shore of the Bahía de Salinas and may have penetrated the low coast range. Otherwise it is unknown as far as lichens are concerned. The plain of the Tempisque is used for grazing with some sugar cane grown in the southwest part in the vicinity of El Paso. The underlying rock and soil in Liberia is white cascajo, a soft pumice laid down in water and hence somewhat stratified. Further south there are clay deposits. Rainfall is high during the rainy season but the dry season is hot and dusty, unofficial temperature in the

shade rising as high as 108°F. in the hottest part of the day and correspondingly cool at night. Wind velocities are high where the trade winds sweep through the passes between the volcanoes in the first half of the dry season, so that most of the perennial vegetation is that of the arid regions and may account for the similarity of the flora with that of Nicaragua and the north. Here grass fires are even more frequent in proportion to the population and more destructive, hence the region is seldom visited by botanists; in fact I have failed to find any collections from this region or any mention of it in botanical works. In 1930 I was able to spend about two weeks in the vicinity of Liberia.

The western slopes of the Cordillera de Tilarán are used for grazing, with small cafetales located in sheltered, moister areas. The vegetation does not appear much different from the plain of the Tempisque, especially on the exposed slopes, but in the sheltered ravines more delicate types survive. This region has not been visited by botanists to any great extent, although Standley and J. Valerio collected in the vicinity of Tilarán in 1926, and Valerio probably made studies of the local flora of Tilarán while he was stationed there as a teacher some years ago. Besides a week in Tilarán I spent about a week at 700 m. on the slopes of Santamaría, the next peak south of La Vieja, and a week at La Granadilla on the plateau between the R. de las Cañas and the R. San José which culminates at 960 m. in the Cerro de San José.

In Santamaría and Tilarán, even during the dry season, much of the time the weather was characterized by mists and high winds and much rain, while a short distance lower and to the west there was neither mist nor rain. However, the brief intervals of hot sun are sufficient to keep the xerophytic vegetation on the wind-swept prairie, while the sheltered ravines and shaded hillsides have mesophytic types. At Tilarán we crossed the continental divide into the headwaters of the Río Frío system with a change in vegetation even more striking than in the pass at Ochomogo in the Meseta Central.

The Cerro de San José rises sharply above the surrounding peaks to 960 m., somewhat higher than the near-by peaks of the

continental divide. It seems to be composed of stratified sedimentary rock sloping 40° S, 70° W. To the west rises the lower exploded crater of Cerro Pelado, while to the east lie the lower peaks which form the junction of the Cordillera de Tilarán and the Cordillera Central. Though the region is considerably drier than the same elevations on the Cordillera de Tilarán, yet it maintains a luxuriant forest vegetation where it has not been cleared for potreros. Being an isolated wind-swept and fire-swept peak, the vegetation of the summit has a stunted, subalpine appearance. The Hacienda Granadilla on the plateau between the Río de las Cañas and the Río de San José at about 500–600 m. furnished much interesting material, especially as we were fortunate in finding two huge pochotes (? *Bombax elliptica* HBK.) which had blown over so recently that the crustose lichens were still fresh and the clusters of orchids and bromeliads were still in bloom. These furnished about the only collections to show the flora of the tree tops in Guanacaste.

The region between the Cerro de San José and Puntarenas has not been visited by botanists to my knowledge, although it is quite accessible on account of the Abangares and other gold mines which have been exploited more or less continually since colonial times. Since the region is of a different geological formation it would probably well repay investigation, as would also the calcareous Santa Catalina range between the R. Tempisque and R. Bebedero at the head of the Gulf of Nicoya.

The peninsula of Osa between Golfo Dulce and the Pacific consists of low mountain ranges, probably of sedimentary rock; at least such were the outcrops observed along the shore and in the gorge of the Quebrada de la Laja, a tributary of the Río Nuevo. G. Cufodontis, of the Austrian expedition of 1930, visited the region in the immediate vicinity of Puerto Jiménez (Santo Domingo, on many old maps and charts, on the small bay just above Puntarenitas). Two weeks later I visited the same region, also the Hacienda Sándalo between the Tigre and Terrones Rivers (marked Necki on the charts). The coastal plain about a mile wide slopes gradually from the beach to about 30 m. and then more steeply up the spurs of the range which follows the west coast of the Golfo Dulce. The forest is still virgin in most

places and consists of a rather open palm and hardwood forest characteristic of well-drained areas. The coast between the tide levels has a characteristic mangrove swamp. Mr. Dunlap, of the United Fruit Company, visited this region a few years ago but I have not learned of any specimens taken. Mr. H. J. Marks, the proprietor of the Hacienda Sándalo, has sent a few specimens of wood and herbarium specimens of forest trees to Prof. S. J. Record of Yale University.

Practically nothing is known of the flora of the islands off the west coast. The only one which has been visited by botanists, Isla Coco, has so far yielded very few foliose or fruticose species. Dr. H. K. Svenson, botanist of the Astor expedition, one of the latest to visit the island, describes it as follows: "The lichen flora must be very inconspicuous; I did not go out of my way to look for lichens but if any large forms had been in my path, I believe I would have picked them up. Cocos Island is entirely covered by a rank vegetation which the sunlight rarely penetrates." So far the only species reported are one *Leptogium* and two *Parmelias*, all wide-ranging species of the tropical lowlands.

Botanical Exploration

Of early botanical exploration in Costa Rica the little that is known apparently indicates that few or no cryptogams were collected. Martín Sessé and José Mariano Mociño probably visited the Pacific Coast between 1795 and 1804. The "Sulfur," with George Barclay as botanist, entered the Golfo de Nicoya about 1840 and about the same time Emmanuel Friedrichstahl visited a portion of Nicaragua and Costa Rica though his collections were not carefully labeled as to locality, all the sheets being marked Guatemala.

Between 1845 and 1851, the "Herald" probably visited Pedregal, the harbor for Davíd, Panamá, as Seemann the botanist brought back from Boquete and the neighboring volcano of Chiriquí, lichens which were studied by Churchill Babington and published by Seemann (1852–1857). These specimens are in Babington's herbarium at Cambridge University and in the Royal Botanic Gardens at Kew.

The first to make extensive collections was Anders Sandøe

Ørsted (1816–1872), to whom we owe the first elaborate accounts of the natural history of Costa Rica. For details of his travels and lists of plants collected at various places, see Ørsted (1848, 1851, 1863), Hemsley (1878–1888), and Durand & Pittier (1891). He entered the country at Puntarenas, passing over the old carretera which ascended the Cerros de Aguacate thence via Alajuela to San José, where he made his headquarters for some time. From this point he visited C. Escazú and Pacaca, penetrating to the mountains of Jarís to the south. He also visited Candelaria, probably in the vicinity of Tablazo, judging from the list of plants he collected in that locality. In May, 1847, he explored Poás and Barba. Earlier in that year he had spent some time studying the volcano Irazú, making his headquarters in Cartago. From this point he visited Aguacaliente and Ujarrás (probably the valley below the modern Paraíso), then made the very difficult trip to Moin over the old trail now largely abandoned, passing Cervantes, Río Birrís, and Quebrada Honda to Naranjo (the modern Juan Viñas), thence to Turrialba, keeping along the shelf of land above the lake near Tunnel Camp, Bonilla, etc. to the customs house on the R. Reventazón (probably below the present La Junta) where he crossed the Reventazón in canoes and proceeded along the coastal plain to Moin.

Another long trip was his visit to Guanacaste and adjacent Nicaragua, the details of which were published in 1848 from a letter he had sent home. He does not state in what year this trip was undertaken, but since the mention that Puntarenas was then a free port (this having been decreed in 1847) and since he was visiting volcanoes in February and May, 1847, it is probable that he made the journey in 1848. He was persuaded by government officials to explore a possible route for an inter-oceanic canal between the Lago de Nicaragua and the Pacific. The party, headed by Francisco Gutierrez, left San José on February 17 for Puntarenas, where they took a huge canoe up the Gulf of Nicoya and thence up the Río Tempisque. On March 8 they set out with a pack train from Santa Rosa for the Hacienda Sapoa just above the junction with R. Bolaños. Thence they visited H. Las Animas above the junction with the R. Guachepelín, ascending that valley and descending the R. Tortuga,

the next river east of the R. Sapoa. Ørsted may have visited some of the islands in the Lago de Nicaragua before he ascended the Río Sapoa to the junction of the Sansapote and overland to the H. Sapoa. Another trip was taken to the Golfo de Bolaños, thence over the height of land and down the Sansapote to its junction with the Sapoa.

Ørsted also visited San Juan del Norte (Greytown), crossing the pass between Barba and Irazú at La Palma and descending along the Río Sucio and the R. Sarapiquí. It is not known whether he sailed from San Juan del Norte or from Puntarenas, which was frequently visited by Danish vessels at that period, thirteen having called there in 1853.

Warscewicz, coming from Guatemala via El Salvador and Nicaragua, is said to have met Ørsted in Nicaragua before reaching Costa Rica via the R. Sarapiquí. He evidently visited Irazú and Turrialba, but I have seen no lichens from his collections.

Ørsted's huge collections are to be found in Kjøbenhavn where their study has only recently been completed. They were distributed about 1931. The fungi were sent to Elias Magnus Fries at Upsala and were published promptly by him in 1851, portions of the collections being found in both Kjøbenhavn and Upsala. The lichens were sent to Th. M. Fries but only a single number, *Stereocaulon obesum* Th. M. Fr., was published. Some have since been named and inserted in the herbarium at Upsala. Through the kindness of Professor N. Svedelius, the remaining unnamed specimens were turned over to me for study and are reported in this work. At present none of Ørsted's lichens are at Kjøbenhavn but it is probable that a complete set of duplicates will eventually be deposited in that herbarium.

Ørsted was soon followed in Costa Rica by a number of naturalists who have left us long accounts of geology and natural history. Many resided in Costa Rica for several years, but few appear to have collected lichens.

During his visit, Polakowsky collected a few specimens studied by Nylander (1876) and apparently distributed quite widely, as I have seen a complete set in Berlin and scattered numbers in other herbaria.

A new era for Costa Rican natural history began with the establishment in 1887 of the Instituto Fisico-geografico Nacional de Costa Rica, with Henri Pittier as its first director. Due to his enthusiastic explorations and those of his fellow botanist, Tonduz, a large herbarium was assembled in San José and materials were sent to many foreign collaborators for study, resulting in the publication of Durand and Pittier (1891–1901). The lichens which were studied by Müller Argau were largely from two extensive expeditions to the southwestern portion of the country and scattered numbers collected by others in various parts of the country. Pittier (1891) described these expeditions in detail. As these collections will be frequently mentioned I have thought it wise to include an abstract of their itinerary.

On January 15, the first expedition reached San Marcos de Dota, the capital of the canton of Tarrazú, the next night Santa María de Dota, and the C. del Angelo, small valley of El Copey 1790 m., and El Roble 2670 m., on the following day. On January 18 they passed Alto de la Baraja 2933 m., Rancho de las Vueltas, C. de las Vueltas 3019 m., and Ojo de Agua 2760 m.; on January 19 the Paramo de las Vueltas and the C. de Buena Vista 3299 m., and La Muerte at 3130 m.; on the 20th, southward along the slopes of Buena Vista to Lagunilla 1857 m., the Alto del Palmital at 1211 m., reaching El Géneral on the evening of January 21 where they stayed until January 28, 1891, and whence Biolley returned to San José. Pittier and Tonduz continued to Buenos Aires, Térraba, and Boruca, whence Pittier returned by a somewhat different route to San Marcos and San José, arriving on February 23, while Tonduz stayed in the field until March 8, 1891.

The following season Tonduz left San José on October 18, 1892, more or less retracing the journey of the previous season to Buenos Aires, thence down the R. Grande de Térraba or Diquís, stopping some time at Boruca, finally down the river to the coast and back by sea to Puntarenas, stopping at several points, arriving on April 17, 1893. The material from these two trips furnished the bulk of material upon which Müller Argau (1891, 1893) based his account of the lichens.

These collections are to be found in the Herbier Müller Argau,

which was purchased by the Herbier Boissier and is now at the Université de Genève. I have been told that a duplicate set exists in Brussels, but apparently none was returned to the Museo Nacional in San José.

C. Wercklé, an engineer who resided in Costa Rica for many years, collected much in the vicinity of Cartago. His specimens were determined by Lindau and may be seen in Berlin and in Wercklé's herbarium at the Museo Nacional de Costa Rica. Wercklé was not at all discriminating in selecting samples for Lindau, so that most of the material in San José needed revision.

The Calverts (1917) spent a year, 1909–1910, in Costa Rica and have given us a good account of its natural history. They brought back some plants which are in the herbarium of the University of Pennsylvania, but I have seen only one lichen from them (at the Farlow Herbarium). Maxon and assistants have visited Costa Rica for ferns and brought back some lichens which were sent to G. K. Merrill for study and are now to be found in the Farlow Herbarium (which acquired the Merrill herbarium) and in the National Herbarium of the Smithsonian Institution at Washington.

Paul C. Standley, in 1924 and again in 1925–6, in company with Juvenal Valerio Rodriguez and Ruben Torres Rojas, made very extensive collections of lichens although his primary interest was angiosperms. These lichens were likewise sent to G. K. Merrill who was studying them at the time of his death. As curator of the Farlow Herbarium I continued this study in preparation for my trip to Costa Rica and am here reporting these collections.

In 1925, during a two-weeks' visit, I secured a large amount of material from Cerro Carpintera and again in 1929–30 I secured several thousand specimens of cryptogams which are still being studied. The most complete set of these plants is in my personal herbarium and the next set, lacking only a few numbers of the commoner species, is at the Farlow Herbarium.

Karl Danielson, an assistant to H. E. Stork, in 1928 collected a few numbers of lichens which are now at the University of Michigan. These are also reported here for the first time, duplicates being found in the Farlow Herbarium and in my own herbarium.

In 1929 and 1930 the Costa Rican government botanist, Alberto M. Brenes, collected many lichens in the vicinity of San Ramón and a few from other parts of the country. These were also turned over to me for study and are to be found in the Museo Nacional, with duplicates in my own herbarium and in the Farlow Herbarium.

The Oesterreichische Costa Rica Expedition, under the leadership of Otto Porsch (1932) with G. Cufodontis as assistant botanist, spent the late verano and early invierno in Costa Rica, visiting much the same territory as I did. If lichens were collected they were probably studied by Zahlbruckner but I have seen no publication on this group, although many of the other groups are already published.

Floristics

It is too early to draw any very definite conclusions regarding the distribution of plants and the affinities of the flora, but certain typical distributions are evident.

Families and genera which are abundant in the northern United States and are often widespread in the North Temperate Zone are usually found at the higher altitudes and reach their southern limits in the mountains of Colombia, except for occasional isolated species farther south. Such an example is the Peltigeraceae, which are widespread and abundant in the northern part of the United States. Only two genera, *Nephroma* and *Peltigera,* reach the American tropics. *Nephroma* is represented by a single species seen in only one restricted locality in Costa Rica. *Peltigera* is represented by about eight species, mostly strictly tropical with only one undescribed species reaching Magellanes, Chile.

Another typical example is a northern family, which is characteristic of the Atlantic Coastal Plain, the Collemaceae. Here genera are mostly common to the eastern and western hemispheres but subgenera and species are much more restricted in distribution. These are mostly found on the coastal plains of Costa Rica, being characteristic on the plains of Guanacaste and occasional on the Atlantic Coastal Plain but not yet reported from Panamá. The species belonging in these genera from the

higher elevations have relations with those of the mountains of Colombia and not with those north of the Isthmus of Nicaragua.

A third type of distribution is found in those families which are predominantly southern, as in the Stictaceae. Here we find them highly developed and characteristic in the highlands, relatively rare in the lowlands. The genera and subgenera are world-wide in distribution and the species also have wide ranges, becoming less frequent in numbers and in species in the North Temperate Zone. In this group, however, species of the mountains of Costa Rica may extend into North America along the Atlantic Coastal Plain, even as far as the Avalon peninsula of Newfoundland, while the species of the Coastal Plain in Costa Rica are southern in their ranges.

Finally some cosmopolitan families in which it is difficult to determine a center of distribution have genera or subgenera which are strictly limited to tropical America.

Further consideration of problems of distribution may be deferred until the systematic enumeration is complete. In general the affinities of the flora seem to be with eastern Brasil but since we have very few collections available from the intermediate mountain ranges of eastern Colombia and southern Venezuela and British Guiana, it is likely that stations of many of these species will eventually be discovered in these regions. Relatively few species are common to Mexico and Costa Rica or to Perú and Costa Rica, and practically no Costa Rican species extend as far south as Chile.

In the following systematic enumeration I have included in the keys to species all those which have been described from tropical America, whether they have been found in Costa Rica or not. I have not included species which were not originally described from this area, although they may have been reported from it, since often these reports have been based on misdetermined specimens. While it is evident that political boundaries do not always coincide with natural floristic divisions, for the purposes of this study tropical America may be defined as Mexico and the West Indies southward to Perú, Bolivia, Paraguay, Brasil, and Uruguay. These are quite natural in the present state of our knowledge, as the lichen flora of northern

Mexico which might be expected to show affinities with that of the southwestern United States is practically unknown. Similarly, that of northern Argentina, which might be expected to be similar to that of adjacent Paraguay, has been little explored for cryptogams. Northern Chile, largely desert, has also been little studied, while the flora south of the desert has relatively few species which have been reported from tropical America as here defined. The greatest difficulty occurs in the exclusion of southern Florida where occur many species which are tropical rather than northern in their affinities. Fortunately for our purposes comparatively few species have been described from this region.

KEY TO TROPICAL AMERICAN FAMILIES OF FOLIOSE AND FRUTICOSE LICHENS

Apothecia more or less exposed, paraphyses growing above the asci to form a tissue, asci early evanescent, leaving an enclosed dusty spore mass (mazedium).......................CONIOCARPINEAE

  Thallus foliose or fruticose, corticate, apothecia sessile .... SPHAEROPHORACEAE

Apothecia linear, elongate-elliptic or angular, not forming a mazedium.......................GRAPHIDINEAE

  Thallus fruticose, erect or dependent, with a basal layer attached to the substrate, corticate [not yet reported between Lower California and Perú]; maritime .......................ROCCELLACEAE

Apothecia circular, not forming a mazedium.............CYCLOCARPINEAE

  Thallus strictly crustose, but fruiting structures appearing fruticose owing to the proliferation of the apothecia from the margins, easily mistaken for a hepatic on cursory examination; Guiana........*Polystroma*

  Thallus loosely byssine from filaments of *Cladophora* or *Trentepohlia*, apothecia with light-colored parathecium............ COENOGONIACEAE

  Thallus filiform or dwarf fruticose, or squamose, very rarely small foliose [deferred for further treatment with the crustose species].

    Algal symbiont *Scytonema* or *Stigonema*, apothecia more or less sunk in the thallus, small and easily overlooked.................EPHEBACEAE

    Algal symbiont Chroococcaceae.......................PYRENOPSIDACEAE

    Algal symbiont *Rivularia*.......................LICHINACEAE

  Thallus gelatinous, swelling greatly when moistened, dwarf fruticose, squamose or large foliose, algal symbiont usually *Nostoc*........COLLEMACEAE

  Thallus definitely foliose or fruticose, or if small, the form of the thallus not due to the algal symbiont.

    Hypothallus and rhizoids highly developed, thallus squamose to small foliose, upper surface corticate, algal symbiont usually *Nostoc*..PANNARIACEAE

    Hypothallus evanescent.

      Thallus large foliose, algal symbionts Nostocaceae or Palmellaceae, spores fusiform to acicular, 2 or more celled.

Both surfaces corticate, lower surface interrupted by more or less highly developed breathing pores, apothecia with well-developed parathecia or amphithecia, stipitate or sessile.....STICTACEAE
Only upper cortex developed, the lower surface tomentose with more or less highly developed network of veins and tufted rhizoids, apothecia attached to the thallus over their whole under surface without true parathecium or amphithecium although surrounded by the torn remains of the tissue covering the young apothecium........................PELTIGERACEAE
Thallus squamose or small foliose, only upper surface corticate, algal symbiont *Pleurococcus*, apothecia with well-developed light-colored parathecium, spores various.
No secondary thallus or podetia present, apothecia sessile...PHYLLOPSORACEAE
Secondary thallus or podetia present, varying from simple stalk of apothecium without algae to highly developed branched or infundibuliform structures, primary thallus squamose or small foliose, often evanescent or degenerate, perhaps crustose in some species..............................CLADONIACEAE
Thallus large foliose or fruticose, algal symbiont *Pleurococcus*, spores one- or two-celled or muriform, never elongate-fusiform to acicular.
Apothecia with black parathecium, spores one-celled [in *Gyrophora haplocarpa* from Perú, the only species of the family so far reported]..GYROPHORACEAE
Apothecia with bright-colored amphithecia.
Spores not placodiomorphous.
Thallus foliose, spores one-celled..................PARMELIACEAE
Thallus fruticose.................................USNEACEAE
Spores placodiomorphous.
Spores hyaline, thallus usually bright yellow, at least the epithecium orange ......................THELOSCHISTACEAE
Spores brown, thallus usually more or less glaucous, epithecium brown or pruinose........................PHYSCIACEAE

SPHAEROPHORACEAE

Thallus foliose or fruticose, corticate on both surfaces or the lower surface incompletely corticate, with *Protococcus*. Apothecia sessile on the margin, or on the lower side of the thallus, open at first or enclosed by an amphithecium.

Only two genera have been reported from tropical America, both fruticose with solid axis and terminal apothecium. *Acroscyphus sphaerophoroides* Lév. without an amphithecium has been reported from Mexico and Perú but has not been found in Costa Rica. *Sphaerophorus* is typically Subarctic-Antarctic in distribution, coming southward on the higher mountains with

a single species on the higher mountains of tropical America. The whole family is greatly in need of revision.

SPHAEROPHORUS MELANOCARPUS (Sw.) DC. apud Lam. & DC., Fl. Franç. ed. 2, 6: 178. 1805, excl. syn.

Lichen melanocarpus Swartz, Nova Gen. Sp. Pl. Prodr. 147. 1788.

Type: Jamaica, *Swartz.*

Thallus ashy glaucescent or pale above, pale below, partly terete, partly compressed, smooth, not rugose, highly branched, 1–6 cm. high, primary branches 1–4 mm. thick, KOH yellow above, KOH – below, $CaOCL_2$ – ; cortex 20 μ thick, subpellucid, of thick-walled conglutinate irregularly woven hyphae; medulla I –, composed of hyphae 4–8 μ thick; mazedium oblique in the ends of the thicker terete branches, becoming disciform, exciple lacerate, ascospores 7–11 μ in diameter. Spermatogonia immersed in the tips or in the lower surface of the branches, opening by a blackened verruciform mouth; spermatia oblong, 1 x 3 μ [description from Nylander and Vainio].

The Costa Rican material does not altogether agree with the above description, but there is so much variation in macroscopic appearance that only a careful monograph can settle the number of species and their relationships.

Cartago: F. V. Turrialba, 2000–2400 m., *Standley 35313.*

San José: L. la Chonta, n. e. Sta. María de Dota, 2000–2100 m., *Standley 42290;* C. de las Vueltas, 2700–3000 m., *Standley & J. Valerio 43832.*

Heredia: C. Zurquí, 2000–2400 m., *Standley & J. Valerio 50436.*

ROCCELLACEAE

This strictly maritime family has not yet been reported between Lower California and Perú, probably because no suitable maritime habitats have been visited by botanists, for the group is abundant in such strictly tropical habitats as the Galápagos Islands. I did not have an opportunity to visit such myself, but had I been able to visit the cliffs along the various headlands between Puntarenas and Golfo Dulce, it is possible that I might have secured some representatives of this family.

COENOGONIACEAE

Thallus spongy byssoid, either adnate or forming dimidiate shelving masses, homoeomerous with *Trentepohlia* or *Cladophora,*

whose filaments are partially surrounded by hyphae. Apothecia with pseudoparenchymatous parathecium; asci 8-spored; spores hyaline, one- or two-celled; spermatia exobasidial.

Thallus with *Trentepohlia* .... *Coenogonium*
Thallus with *Cladophora*, apothecia unknown .... *Racodium*

COENOGONIUM Ehrenb.

Coenogonium Ehrenberg apud Nees ab Esenbeck, Horae Physicae Berol. 120. 1820.

Thallus loosely spongy byssoid, either adnate or forming dimidiate shelving masses (suggesting a thin species of *Polystictus*), homoeomerous with *Trentepohlia* which is partially surrounded by a network of hyphae. Apothecia scattered on the upper surface, scutiform, usually with a short stipe, with a parathecium of thin-walled pseudoparenchyma without a medulla; paraphyses unbranched, often with swollen tips; asci 8-spored; spores hyaline, fusiform, ellipsoidal to elongate, one- or two-celled; spermagonia spherical, spermatia exobasidial, fusiform, straight; spermatiophores mixed with anaphyses.

Clements segregated the species of *Coenogonium* with unicellular spores as *Holocoenis*. However, his proposal has not been followed by other authors, although Vainio and Zahlbruckner have proposed sections on this basis, Vainio using *Coenobiatora* and *Coenobiatorina*, while Zahlbruckner incorrectly adopted *Holocoenis* and *Coenobiatorina*.

This family is very aberrant among lichens in several respects and perhaps would be better dropped and the species distributed among the fungi and algae. It seems more logical to regard the group as a case of parasitism of fungi on algae, as neither fungus nor alga seems to influence the development of the other, and there has been no further evolution resulting from the acquisition of a photosynthetic unit by the fungus. Taking this view, one would recognize about four or perhaps five species of fungi from tropical America, one species with unicellular spores about 6–10 x 2.5–4 μ belonging in *Patinella;* and three or four species with 2-celled spores belonging in *Orbilia* or a segregate from that genus. Among the algae one would recognize a dozen or more species of *Trentepohlia* which are often subject to the attacks

of *Patinella* and *Orbilia*. In the following key to the tropical American species of *Coenogonium*, as it is commonly understood by lichenologists, it will be noted that out of nineteen names proposed, four were based on specimens in which no apothecia were found. Four other species originally described in *Coenogonium* have already been transferred to *Trentepohlia*. I have carefully investigated the ascocarps of the fertile Costa Rican specimens and can find few characters which would separate species from each other, except spore size and septation. For lack of time to investigate this question thoroughly, I have here followed the traditional arrangement, as to do otherwise would involve serious nomenclatorial difficulties. To adopt the view that this group should be excluded from the lichens would invalidate *Coenogonium*, as based on a combination of characters of parasite and host and involve redescription of its species in *Patinella*, *Orbilia*, and *Trentepohlia*.

KEY TO THE TROPICAL AMERICAN SPECIES OF COENOGONIUM

Apothecial disc livid, cell walls brownish; spores unicellular; algae 11–16 μ in diameter; French Guiana.................................*C. Leprieurii*
Apothecia carneous, yellowish or waxy white, never livid.
  Thallus dimidiate, not adnate to the substrate.
    Thallus thick, rigid, with white subsilky villum, zonate, sterile; Brasil.. ....*C. Echinus*
    Thallus thinner.
      Filaments 7–9 μ in diam., cells not very distinct, greenish, subdiffuse, stratose.......................................*C. subvirescens*
      Filaments 12 μ in diam., rigid; Brasil..........................*C. Linkii*
      Filaments thicker, 16–20 μ in diam., thallus less rigid.
        Cells 4–5 times as long as broad; Mexico................*C. confervoides*
        Cells about twice as long as broad; spores 7–8.5 x 2–3 μ; Brasil.... ....*C. acrocephalum*
      Filaments and paraphyses thick, imperfectly known............*C. andinum*
  Thallus adnate to effused.
    Filaments moniliform, 18 μ in diam.; thallus glaucous green to tawny brown, margins paler; spores 2-celled, 3–4 times as long as broad; Cuba...*C. moniliforme*
      Filaments partially moniliform, partly cylindrical, cells 20–25 μ in diam.; Costa Rica.............................*C. heterotrichum*
    Filaments uniformly cylindrical.
      Filaments 23–36 μ in diam.; striate apothecia 0.6–0.7 mm. in diam.; spores 11–15 x 25–35 μ, 2-celled...............*C. disjunctum*
      Filaments 20–28 μ in diam.; spores unicellular, 6–10 x 3 μ; Borbonia or Louisiana..............................*C. interpositum*

Filaments 17–20 μ in diam.; cells 30–50 μ long; spores 8 x 2.5 μ, 2-celled; Costa Rica . . . . *C. interponendum*
Filaments 15–17 μ in diam.; thallus ashy green, pulvinate, up to 2 cm. broad; Perú . . . . *C. pulvinatum*
Filaments 12–16 μ in diam.; thallus yellowish; spores 8–10 x 3 μ; Colombia . . . . *C. interplexum*
Filaments 12–14 μ in diam.; thallus yellowish to green; St. Vincent . . . . *C. Leprieurii* v. *panniforme*
Filaments 8–11 μ in diam., conglutinate in fascicles 70–90 μ in diam.; spores 7–10 x 3.5–4.5 μ; Bolivia . . . . *C. complexum*
Filaments 4–8 μ in diam.
  Filaments non-articulate; spermatia 7–9 x 15 μ; paraphyses clavate; Brasil . . . . *C. dialeptizum*
  Filaments articulate; spermatia not reported.
    Cells 2.5–4 times as long as broad, paraphyses obovoid; Brasil . . . . *C. pannosum*
    Cells 1.5–3 times as long as broad, sterile; Brasil . . . . *C. depressum*
Filament size not given, rugulose, articulate-branched, coalesced into fascicles; Venezuela . . . . *C. Tuckermani*

COENOGONIUM LEPRIEURII Nyl., Ann. Sci. Nat. Bot. IV, **16**: 89. 1862.

C. Linkii var. *Leprieurii* Mont., Ann. Sci. Nat. Bot. III, **16**: 47. 1851.

Holocoenis Leprieurii Clements, Genera of fungi, 174. 1909.

Type: Guayane Française, *Leprieur*, sine no.

Algae loosely woven, yellowish, 11–16 μ in diameter. Apothecia plane or convex, excluding the white margin, disc livid from the first; asci about 20 μ in diameter; spores oblong to fusiform or ellipsoidal, unicellular, 6–10 x 2.5–4 μ; paraphyses slender, apices clavate.

I have not seen this species from Costa Rica but *Dodge & Nevermann 7399*, from jungle at Castilla farm, 20 m., Limón Province, seems to be a variety of this species. The fungus is not well developed but has a livid disc, the margin is still thick and white, and the alga is of much smaller diameter. The exciple is composed of isodiametric cells with colored walls. It appears to be the same fungus attacking a much smaller alga, and should be referred to *Patinella*.

COENOGONIUM SUBVIRESCENS Nyl., Flora **57**: 72. 1874.

C. Leprieurii var. *subvirescens* Nyl., Ann. Sci. Nat. Bot. IV, **16**: 89. 1862.

Type: Brasil, Amazonas, Rio Negro, *Spruce 28*, is type of the

species, while *C. Leprieurii* var. *subvirescens* was described from French Guiana without collector.

Algae somewhat interwoven but more or less parallel, 7–9 μ, forming a loose dimidiate to subcircular thallus depending upon position and shape of substrate, not or obscurely zonate, pale to dark olive buff, cells about 21–24 μ long, septa not very evident, other cell walls thick, chloroplasts appearing somewhat in the shape of a dumb-bell with the pigment more or less massed at the ends of the cells.

Apothecia about 800 μ in diameter, tapering below to a short stipe about 250 μ in diameter, composed of thick-walled pseudoparenchyma with the outer 40 μ composed of a palisade of elongate cells, perpendicular to the surface; parathecium about 80 μ thick, homogeneous with the rest of the apothecium, the hypothecium very thin, filamentous, of cells with thinner walls. The hymenium is about 80 μ tall and is composed of filiform paraphyses with clavate tips and slender clavate asci. The ascospores are not mature in my specimens but seem to be slender, 2-celled, probably about the size of most of the other spores in the genus except *C. disjunctum.*

Limón: Cadiz, *Dodge 7452;* Castilla farm, 20 m., *Dodge & Nevermann 7451;* Monte Verde, *K. Danielson 73;* Siquirres, 70–200 m., *Dodge, Catt & Thomas 5574;* La Colombiana, 70–80 m., *Standley 36885.*

Cartago: R. Pejivalle, 650–800 m., *Dodge & Thomas 4408;* El Muñeco, on R. Navarro, 1400–1500 m., *Standley & J. Valerio 51055;* C. Carpintera, 1500–1850 m., *Standley 35596.*

Puntarenas: Osa, Golfo Dulce, *Dodge 7450.*

Guanacaste: Q. Serena near Tilarán, 700 m., *Standley & J. Valerio 46242;* Santamaría, 720–850 m., *Dodge 7015.*

COENOGONIUM LINKII Ehrenberg ap. Nees ab Esenbeck, Horae Phys. Berol. 120. 1820.

C. controversum Pers. ap. Gaudich. in Freycinet, Voy. Uranie, Bot. 214. 1826 (nom. nud.).

Type: Brasil, Sta. Catharina, *Chamisso.* The type of *C. controversum* came from the walls of the aqueduct of Corcovado, Rio de Janeiro, *Gaudichaud.*

Algae somewhat interwoven but more or less parallel, about 12 μ in diameter, forming a somewhat rigid dimidiate to suborbicular thallus, not or obscurely zonate, pale to dark olive-buff, cells 40–60 μ long, septa very difficult to observe, chloro-

plasts small and scattered, outer cell walls thick, partially covered with anastomosing fungal hyphae.

Apothecia warm buff, about 850 μ in diameter, tapering sharply to a short stipe about 240 μ in diameter and up to 300 μ long, pseudoparenchymatous, without palisade layer at the surface; parathecium about 100 μ thick, homogeneous with the rest of the apothecium, the hypothecium very thin and soon evanescent; the hymenium about 80 μ tall, composed of filiform paraphyses with swollen tips and cylindrical asci. The ascospores are not fully mature in my specimens but probably the common size for the genus.

Cartago: C. Carpintera, 1800 m., *K. Danielson 9.*
Alajuela: La Palma de S. Ramón, 1100 m., *Brenes 175.*
Guanacaste: El Silencio, near Tilarán, 750 m., *Standley & J. Valerio 44619.*

COENOGONIUM CONFERVOIDES Nyl., Flora **41**: 380. 1858.
?*C. andinum* Karsten ap. Nyl., Bot. Zeit. **20**: 178. 1862.

Type: Mexico, Orizaba, *Fr. Müller* (Schimper Herb.). Type of *C. andinum* from Colombia, 2000 m., *Lindig 2560,* also Perú, *Weddell,* and southern Brasil, *Guillemin.* Since I have been unable to see the types, the interpretation of this species is difficult. In Ann. Sci. Nat. Bot. IV, **11**: 242. 1859, Nylander amplified his very inadequate description, basing his emendations on a specimen from Tahiti, *Lépine 14.* When he monographed the genus in Ann. Sci. Nat. Bot. IV, **16**: 91. 1862, he cited *Lepine 14* from Tahiti first, adding Guadeloupe Island, *Duchassaing,* Brasil, *Gaudichaud,* and *Weddell,* and Chile, *Gay,* not citing the original Mexican type. Since none of these descriptions was based on specimens having apothecia its application is further confused. Since the descriptions only state how it differs from *C. Linkii,* I have assumed that the thallus is more or less dimidiate with a larger alga than in that species. Nylander also notes that a specimen from Colombia, Bogota, 2700 m., *Lindig 887,* has algal filaments 12–18 μ in diam. Unfortunately I have been unable to see any of the above-mentioned specimens. The following description is based on Costa Rican specimens.

Algae somewhat interwoven but more or less parallel, 16–20 (–28) μ in diameter, forming a soft dimidiate or suborbicular thallus, not zonate, pale to deep olive buff, cells about 60–100 μ

long, septa plainly visible, chloroplasts rather indistinct in these specimens, often alternate cells more or less collapsing, giving a somewhat moniliform appearance to old filaments, outer walls thick, not densely covered with hyphae. The collapsed cells sometimes have the coloring matter collected at the ends, giving the dumb-bell appearance to the chloroplast as in *C. subvirescens*.

Apothecia warm buff, 560 μ in diameter, patelliform, with stipe about 160 μ in diameter and 300 μ long, pseudoparenchymatous, of very thick-walled cells which tend to arrange their long diameters perpendicular to the surface of the apothecium, but not forming a definite palisade as in *C. subvirescens;* the parathecium 40–50 μ thick, homogeneous with the rest of the apothecium, the hypothecium 20–30 μ thick of interwoven hyphae, the hymenium about 60 μ tall, composed of filiform paraphyses with spherical tips and slender cylindrical asci about 5 μ in diameter; ascospores distichous, 4-celled, 10–12 x 3 μ. [The ascospores are immature and so closely packed in the ascus that I am not certain of size and septation, as I have been unable to free spores from the ascus.]

Limón: Waldeck, *Dodge 7453*.

Cartago?: Morpho Valley, 1420 m., *K. Danielson 51* [This locality is uncertain and Danielson's barometric readings are apt to be a little high, but it probably in the vicinity of the upper Reventazón below Cartago, where Lepidoptera of the genus *Morpho* are not uncommon.]

COENOGONIUM HETEROTRICHUM Müll. Arg., Bull. Soc. R. Bot. Belg. **32**: 162. 1893.

Type: Costa Rica, San Marcos de Dota, *Tonduz 6115*.

Thallus pulvinate, cespitose-effused, deep olive buff to dark olive, algae somewhat interwoven, dimorphic, larger filaments 20–25 μ in diameter, cells about 40 μ long, chloroplasts disciform, scattered; smaller filaments submoniliform, the cells of smaller diameter being about 7–8 μ and 12 μ long, those of larger diameter being about 10–12 μ and of about the same length.

Fungus unknown. In *Brenes 29a* the fungal hyphae are brown instead of hyaline.

San José: S. Marcos de Dota, 1200 m., *Tonduz 6115*, type.

Alajuela: La Palma de S. Ramón, 1250 m., *Brenes 29a*.

COENOGONIUM INTERPONENDUM Nyl. ap. Polakowsky, Jour. Bot. Brit. & For. **15**: 225. 1877.

Type: Costa Rica, Cartago, Angostura, *H. Polakowsky 496.*

Algae loosely interwoven, forming an adnate irregular thallus, deep olive buff to citrine drab, cells about 17–20 μ in diameter, 30–50 μ long, pigment quite uniformly dispersed throughout the cell, yellowish green. All my Costa Rican material is sterile. Nylander states that the spores are fusiform, 2-celled, 8 x 2.5 μ.

Limón: Carmen, *Dodge 7449.*
Cartago: Angostura, *H. Polakowsky 496,* TYPE.
Alajuela: La Palma de S. Ramón, 1250 m., *Brenes, 53a, 116, 399.*
Guanacaste: H. Q. Azul on lower slopes of V. Tenorio, 400–600 m., *Dodge & Thomas 8042.*

COENOGONIUM INTERPOSITUM Nyl., Ann. Sci. Nat. Bot. IV, **16:** 91. 1862.

Type: Borbonia, Lepervanche, *Mezières;* Louisiana, *Hale.*

Thallus loosely tomentose intertangled, more or less pulvinate, algal cells 20–28 μ in diameter and 60–88 μ long, chloroplasts appearing the shape of a dumb-bell with the pigment massing at the ends of the cells.

[Apothecia pale carneo-luteous; spores oblong, simple, 6–10 x 3 μ; paraphyses slender or medium.]

As all my Costa Rican material is sterile the reference of it to this species is doubtful. It quite possibly belongs with *C. disjunctum* Nyl., based on specimens from Martinique and Cuba, *Wright 170,* which reaches a slightly larger diameter of algal filament and much larger 2-celled spores. Both species are said to resemble *C. confervoides* and perhaps should be placed in the *C. confervoides* group.

Cartago: C. Carpintera, 1560–1700 m., *Dodge & Thomas 7920.*
Alajuela: La Palma de S. Ramón, 1100–1250 m., *Brenes 53, 115.*

COENOGONIUM INTERPLEXUM Nyl., Ann. Sci. Nat. Bot. IV, **16:** 92, *pl. 12, f. 20, 21.* 1862.

Type: Colombia, 2200 m., *Lindig 2561.*

Thallus loosely interwoven, intricate, algal cells 12–16 μ in diameter and 30 μ long, chloroplasts more or less disciform, scattered.

[Apothecia fleshy-yellow, plane, 1 mm. in diameter, margin waxy, fleshy to white; spores short-fusiform, 2-celled, 8–10 x 3 μ; paraphyses medium, apex clavate.]

Alajuela: Piedades de S. Ramón, 900 m., *Brenes 408.*
Puntarenas: Boruca, 560 m., *Tonduz 6114.*

Coenogonium pannosum Müll. Arg., Flora **64**: 234. 1881.

Type: Brasil, São Paulo, Apiahy, *Puiggari 1026.*

Thallus loosely interwoven, dark olive buff to citrine drab, more or less adnate to substratum, algal cells 6–8 μ in diameter, 28–32 μ long, pigment migrating toward the ends of the cells.

[Apothecia 350–500 μ in diameter, pale or orange white, plane, with paler and thinner margin, finally immarginate and slightly convex, becoming more flesh color; hymenium hyaline, paraphyses very slender with obovoid head about three times as thick as the stalk; asci slender, cylindrical, 8-spored; spores 2-locular, 6–7 x 2 μ, fusiform with acute ends.]

Since my Costa Rican material is sterile its reference here is uncertain and it may be only very young algae of *C. subvirescens* Nyl., with which it agrees in general appearance, but there is no trace of the formation of a dimidiate thallus.

Guanacaste: H. Q. Azul, on slope of V. Tenorio, 500–600 m., *Dodge & Thomas 6654.*

Coenogonium depressum Müll. Arg., Flora **64**: 525. 1881.

Type: Brasil, São Paulo, Apiahy, *Puiggari 1034.*

Thallus adnate, pale olive buff, filaments short, flexuous, depressed, subintricate; cells 4–8(–13) μ in diameter, 16–20 μ long, somewhat inflated in the middle but scarcely enough to give a moniliform appearance, chloroplasts no longer distinct.

As I have not compared the Costa Rican material with the type I cannot be certain of the identity.

Cartago: alpine region of Irazú, *Ørsted.*

Coenogonium implexum Nyl., Ann. Sci. Nat. Bot. IV, **16**: 92. 1862.

Type: Australia, Victoria, Jarvin, *Ferd. Müller.*

[Similar to *C. interplexum* but algal cells a little smaller, 10–13 μ in diameter, spores a little larger, 8–11 x 3.5–4.5 μ, paraphyses thicker.]

The following collection has been referred here by Müller Argau, but I have not studied it.

Puntarenas: Boruca, 560 m., *Tonduz 6113.*

Ephebaceae

Thallus dwarf fruticose, branched, more or less filiform, without rhizinae, crustose or small squamose, with *Scytonema*

or *Stigonema*. Apothecia small, often with very small punctiform disc, scarcely visible; paraphyses well developed or absent; asci 8-spored; spores hyaline, 1–2-celled.

The individuals of this family are so small that they are easily overlooked both in collecting and in sorting material, and so the few species here reported are probably not representative of this group in Costa Rica.

KEY TO TROPICAL AMERICAN GENERA OF EPHEBACEAE

Thallus crustose to small squamose, homoeomeric; Brasil........*Pterigyopsis atra*
Thallus dwarf fruticose, dark, thickly branched.
Apothecia sunken in swellings of the thallus, single or gregarious; spores unicellular; paraphyses present; Brasil..........................*Ephebeia*
Apothecia sessile on the thallus, either lateral or terminal.
Thallus without pseudoparenchymatous cortex or medulla; paraphyses filiform, simple; asci 8-spored; spores ovoid or spherical, unicellular ....*Thermutis*
Thallus with pseudoparenchymatous cortex and medulla.
Spores unicellular................................*Leptogidium byssoides*
Spores 2-celled...*Polychidium*

THERMUTIS E. Fr.

THERMUTIS E. Fr., Syst. Orb. Veg. **1**: 392. 1825.

Gonionema Nyl., Mem. Soc. Sci. Nat. Cherbourg **3**: 163. 1855.

Thallus dwarf fruticose, thickly branched and filiform, without rhizinae, *Scytonema* present with the hyphae running in the gelified sheath. Apothecia small, lateral, saucer-shaped to almost spherical; parathecium often highly developed and thick; hypothecium light-colored; paraphyses unbranched, filiform, tips not swollen; asci clavate, thin-walled, 8-spored; spores hyaline, ellipsoidal, elongate, unicellular, thin-walled. Spermagonia lateral or terminal, sessile, more or less spherical; spermatia small, ovoid, or elongate.

THERMUTIS VELUTINA (Ach.) Fw., Linnaea **23**: 170. 1850.

Lichen velutinus Ach., Lichenog. Suec. Prodr. 218. 1798.

Gonionema velutina Nyl., Act. Soc. Linn. Bordeaux **21**: 262. 1856.

This species has been reported by Müller Argau from the following localities in Costa Rica. The specimens were not studied while I was in Genève.

San José: San Marcos de Dota, 1200 m., *Tonduz 5378*.
Guanacaste: Boruca, 560 m., *Tonduz 5371;* Térraba, *Tonduz 5372*.

A small sterile specimen from Guanacaste: near Tilarán, 500–690 m., *Dodge & Thomas 8031*, may belong in *Polychidium* but the specimen is not definitely determinable as to genus.

COLLEMACEAE

Thallus gelified, crustose to foliose or dwarf fruticose, with or without rhizoids, sometimes umbilicate, homoeomerous with *Nostoc.* Apothecia from sunken almost perithecia to sessile apothecia usually with an amphithecium, occasionally with parathecium; paraphyses simple; asci 8-spored; spores hyaline, spherical to acicular, straight or twisted, 1-celled to muriform, usually with a thin wall (except in *Physma* and section *Lemphospora* of *Lempholemma*).

This family is widely distributed in the temperate and tropical zones, the more highly developed members occurring in the latter. It is possible that some of the smaller and less conspicuous genera have been overlooked or have been included in the crustose material in the preliminary sorting. So far only four genera have been found in Costa Rica.

KEY TO TROPICAL AMERICAN GENERA OF COLLEMACEAE

Spores unicellular.
  Thallus crustose, not gelified, parathecium present; spores ellipsoidal, thin-walled.
    Brasil.................................. *Leprocollema americanum*
    Porto Rico.................................. *L. Finkii*
  Thallus squamulose, gelified; spores spherical, thin-walled but surrounded by a thick gelified sheath.
   Thallus not corticate.................................. *Lempholemma*
   Thallus corticate, wholly pseudoparenchymatous; Juan Fernandez.... .... *Lemmopsis polyschidioides*
   Thallus foliose, gelified; spores ellipsoidal to fusiform, thick-walled, surrounded by a gelified sheath.................................. *Physma*
Spores phragmospores or dictyospores.
  Cortex not developed; apothecia with parathecia only.................................. *Collema*
  Cortex of pseudoparenchyma; apothecia with amphithecia (parathecia often also present).................................. *Leptogium*

LEMPHOLEMMA Körb.

LEMPHOLEMMA Körber, Syst. Lich. Germ. 400. 1855.

Type species: *Lempholemma compactum* Körber.

Thallus from verrucose, squamulose, dwarf fruticose to foliose in our species, gelified when moist, clothed with rhizinae below,

homoeomeric, without cortex, with *Nostoc.* Apothecia superficial or terminal, mostly sunken in the thallus (not in our species); amphithecium either with or without cortex; parathecium colorless, urceolate; hypothecium colorless; paraphyses filiform, simple; asci 8-spored, clavate, often twisted below; spores hyaline, fusiform, ellipsoidal-ovoid or spherical, smooth.

The genus has been divided into eight sections of which only one section *Lemphospora* is tropical. This section is characterized as having apothecia without cortex, spores more or less spherical with a thick gelified sheath. *Lempholemma Dussii* (Vainio) Zahlbr., Cat. Lich. Univ. **3**: 23. 1925 [*Collema Dussii* Vainio, Ann. Acad. Sci. Fenn. A6[7]: 114. 1915] has been described from Guadeloupe in the Antilles.

LEMPHOLEMMA (LEMPHOSPORA) **oblique-peltatum** (Eschw. ap. Martius) Dodge, comb. nov.

Collema oblique-peltatum Eschw. ap. Martius, Icon. Pl. Cryptog. Fasc. 2: 27, *pl. 11, f. 2* [between 1828 and 1833].[1]

Type: Brasil, near Pará, *Martius.*

Thallus foliose, up to 5 cm. in diameter, drying grayish olive to dark olive gray, margin thick, broadly subdichotomously lobed, lobes up to 3 mm. broad and 2–3 mm. long, smooth, surface minutely pitted although appearing practically smooth to the naked eye, without soredia or isidia; thallus 200–400 μ thick, homoeomerous, without cortex, but provided with a thin layer of tangled rhizinae below. Apothecia subsessile, often appearing obliquely attached to the thallus in section, up to 2.5 mm. in diameter, margin of the same color as the thallus, with periclinal folds and wrinkles, disc tawny to mars brown; amphithecium appearing lobulate in section (due to the periclinal wrinkles), homogeneous with the thallus, 200–300 μ thick but extending beyond the parathecium as much as 800 μ; parathecium pseudoparenchymatous, highly developed, about 100 μ thick below, thinning out above to about 50 μ; hypothecium about 40 μ thick, of highly gelified hyphae; thecium about 100 μ

[1] I have been unable to locate the date of the second fascicle of this work. The cover of the copy in the Missouri Botanical Garden gives the pages of text and plates in each fascicle but only the dates 1828–1834. Martius in his 'Flora Brasiliensis' **1**: 233–234. 1833, quotes from the 'Icones' citing page, hence it must have been issued before that date. In this work he placed it in the subgenus *Enchylium.*

tall; paraphyses about 1–2 μ in diameter, clavate above, septate, cells 4–6 μ long, with walls highly gelified so that they appear as slender rows of cells imbedded in a gel; asci clavate-cylindrical, about 80 x 16 μ, containing 8 monostichous spores; ascospores broadly ellipsoidal, 12 x 8 μ while still in the ascus, with a thick gelified wall.

While I have not studied the type specimen of this species, a careful study of the description and the figures shows that it belongs in *Lempholemma* section *Lemphospora* rather than in *Collema*. Judging from determinations observed in various herbaria, this species seems to have been confused with *Leptogium vesiculosum* (*L. bullatum*), *L. tremelloides*, and *L. foveolatum*, although the abundant development of rhizoids below should have separated it. While it is minutely scrobiculate-foveolate (visible under hand-lens), it is not conspicuously so to the naked eye as in *L. foveolatum*. Besides my Costa Rican material I have also seen it from Eustis, Lake Co., Florida, *Nash 2024*, determined by Eckfeldt as *L. faveolatum* (sic) Nyl.

Limón: Waldeck, *Dodge 7404;* near Siquirres, 70–170 m., *Dodge, Catt & Thomas 5588, 8024;* Hamburg, 55 m., *Standley & J. Valerio 48767.*

Guanacaste: H. Santamaría, 720 m., *Dodge & Thomas 6898;* near Tilarán, 340–670 m., *Dodge & Thomas 6644, 8022.*

Puntarenas: near Corozál, 5–50 m., *Dodge 8023;* Puerto Jiménez, *Brenes 839.*

Lempholemma (Lemphospora) **dichotomum** Dodge, sp. nov.

Type: Costa Rica, Guanacaste, H. Granadilla, *Dodge & Thomas 6736.*

Thallus foliosus, ad 5 cm. diametro, 400–650 μ crassitudine metiens, griseo-olivaceus, margine crassiuscula, integra, lobatus, dichotomus, lobi 1–1.5 mm. lati, divergentes, superne longitudinaliter rugosus, sine sorediis isidiisque, inferne rhizinis nigris densissimis intertextis obsitus, homoeomerus, nostocaceus, sine strato corticali. Apothecium peltatum, basi constrictum, ad 2.5 mm. diametro metiens, margine concolori, rugosa, disco fulvo castaneove; amphithecium sectione lobatum, homogeneum, 150–300 μ crassitudine inferne, sed ad 500 μ superne et ultra marginem parathecii; parathecium pseudoparenchymaticum, ad 160 μ crassitudine inferne, attenuatum ad 80 μ superne; hypothecium filamentosum, ad 80 μ crassitudine, hyphis gelifactis; thecium ad 120 μ altum; paraphyses filiformes, apicibus

decompositis brunneis, in materia gelata fixi, cellulis cylindricis, 1 μ diametro, 4–6 μ longitudine metientibus; asci 60 x 10 μ, cylindrici; ascosporae octonae, monostichae, late ellipsoideae, 8 x 12 μ (dum in ascis sunt), membrana incrassata, gelifacta.

Thallus foliose, up to 5 cm. in diameter, 400–650 μ thick, grayish olive, margin thick, smooth, dichotomously lobed, lobes 1–1.5 mm. broad, divergent, upper surface longitudinally wrinkled, without isidia or soredia, lower surface covered with a dense black nap of rhizinae, homoeomerous, with *Nostoc*, without cortical layer either above or below. Apothecium constricted at the base, up to 2.5 mm. in diameter, margin concolorous, irregularly wrinkled, disc tawny to chestnut; amphithecium in sections appearing lobed, homogeneous with the thallus, 150–300 μ thick below but extending up to 500 μ above and beyond the margin of the parathecium which is pseudoparenchymatous, about 160 μ thick below, thinning out to 80 μ at the margin; hypothecium filamentous, 80 μ thick, of gelified hyphae; thecium about 120 μ tall, paraphyses filiform, the apices decomposing brown, imbedded in a gel, cells cylindric, about 1 μ in diameter, 4–6 μ long; ascospores 8 per ascus, monostichous, broadly ellipsoidal, about 8 x 12 μ (while still in the asci), with a thick gelified wall. This species has also been seen from Barro Colorado Island, Gatun Lake, Panamá.

Guanacaste: H. Granadilla, 540 m., *Dodge & Thomas 6737.*

PHYSMA Mass.

PHYSMA Massalongo, Neag. Lich. 6. 1854.

Dichodium Nyl., Bull. Soc. Linn. Normandie II, **2**: 43. 1868.

Type: *Physma Boryanum* Massalongo.

Thallus foliose with rhizinae beneath, corticate with several layers of pseudoparenchymatous cells; algae *Nostoc*. Apothecia superficial, lecanorine, with broad disc, thick margin; hypothecium light-colored; paraphyses filiform; asci 8-spored; spores colorless, ellipsoidal or fusiform, unicellular with thick almost warty wall or with a gelified sheath. Spermagonia sunk in the thallus, showing above by the dark swelling, surrounded by pseudoparenchyma; spermatiophores simple or forked, septate, cells short; spermatia short, straight.

Only two species are known from tropical America, *P. chilensis* Hue from Chile and *P. pruinosum* Vainio, from the Antilles. Material reported from America as belonging to *P. byrsinum* (Ach.) Müll. Arg. (*P. byrsea* (Ach.) Tuck.) is probably misdetermined. Apparently the genus is most highly developed and wide-spread in Oceania and adjacent Asia.

Physma pruinosum Vainio, Ann. Acad. Sci. Fenn. A6[7]: 112. 1915.

A single sterile specimen collected near Cartago, 1500 m., *C. Wercklé*, May 1900 (in Mus. Nac. 17233, and in Herb. Bot. Gard. Berlin), was referred to *Physma byrsinum* by Lindau. It is possible that this species belongs to *Physma pruinosum* Vainio or it may possibly be a very young thallus of *Leptogium marginellum* (Sw.) S. F. Gray. Its spermagonia are marginal and its spermatia are ellipsoidal and small.

COLLEMA Wigg.

Collema Wiggers, Primit. Fl. Holsat. 89. 1780.

? *Gabura* Adanson, Fam. Pl. 2: 6. 1763?

Scytenium S. F. Gray, Nat. Arrang. Brit. Pl. 1: 398. 1821.

Type species: *Collema Lactuca* (Web.) Wiggers [*Lichen crispus* L.].

Thallus foliose or squamulose to almost crustose, gelified when moist, lying on the substrate without rhizinae, homoeomerous, not corticate, hyphal system loose; algae *Nostoc*. Apothecia at first sunken, erumpent, sessile or scutellate and constricted below, with amphithecium; parathecium either present or absent, both parathecium and hypothecium either of interwoven hyphae or pseudoparenchymatous; paraphyses simple, adherent, mostly septate; asci 8-spored; ascospores colorless, cylindric, acicular, fusiform, long-ellipsoidal or ovoidal to almost cubical, ends obtuse or acute, sometimes becoming muriform, thin-walled, without gelified sheath. Spermagonia sunken in the thallus or in thalline warts, with light-colored wall; spermatiophores simple or branched, without sterigmata, septate with short cells; spermatia short, oblong to ellipsoidal, straight.

KEY TO TROPICAL AMERICAN SPECIES OF COLLEMA

Amphithecium corticate; spores acicular.................... COLLEMODIOPSIS

[*C. lherminieri* Hue, from Guadeloupe, is the only species of this typically northern group so far reported. *C. Granadillae* is here reported from Costa Rica.]

Amphithecium not corticate.
Spores oblong to ellipsoidal, more or less muriform; thallus laciniate, more or less granular .... BLENNOTHALLIA
Lobes less than 0.5 mm. broad; apothecia unknown; Chile....... *C. millegranum*
Lobes more than 0.5 mm. broad; apothecia well developed; Mexico.. .... *C. mexicanum*
Spores clavate, ellipsoidal to fusiform, uniseptate, rarely up to 3-septate, not over 30 μ long; thallus narrowly laciniate or incised...... DICOLLEMA
Spores clavate, 14–21 x 4.5–5.5 μ; Brasil, Paraguay, and Argentina.... .... *C. corynesporum*
Spores ellipsoidal or fusiform.
Margins of laciniae nodose-granular...................... *C. pycnocarpum*
Spores 6–9 x 3 μ; Brasil.................................. v. *Minarum*
Spores 10–14 x 3–4 μ; Brasil.............................. v. *Malmei*
Spores 10–15.5 x 4–5.5 μ; Brasil and Colombia.......... v. *crassiusculum*
Spores 14–17 x 4–5 μ; New York and New Jersey............ v. *typicum*
Spores 16–25 x 3–7 μ, 3-septate; Virginia southward.......... *C. cyrtaspis*
Spores 16–30 x 4–5 μ, 1–3-septate; Chile.............. *C. pycnocarpoides*
Margins of laciniae not nodose-granular.
Laciniae 1–3 mm. broad, spores 12–14 x 5–6 μ; Paraguay...... *C. crenatum*
Laciniae under 1 mm. broad, more or less canaliculate below; Cuba.
Laciniae thick.. *C. stellatum*
Laciniae thin, flat; spores 11–17 x 4–5 μ................ *C. solenarium*
Spores fusiform to acicular, more than 3-septate, over 30 μ long; thallus broadly laciniate, often fenestrate.................. SYNECHOBLASTUS
Thallus isidiose; spores over 100 μ in length; Brasil.
Parathecium present, spores 125–175 x 3–4 μ................ *C. leptosporum*
Parathecium absent, spores somewhat over 100 μ in length........ *C. Ramboi*
Thallus not isidiose; spores not over 95 μ in length.
Apothecia white-pruinose.
Apothecia small, crowded on short bullate prominences; spores 50–80 x 3–5 μ; thallus pustulate, not fenestrate; southern United States and southward along coastal plains....... *C. leucopepla*
Apothecia sessile or nearly so, larger; thallus more or less fenestrate; tropical highlands...................... *C. glaucophthalmum*
Spores 77–92 x 6–7 μ; Mexico........................... v. *typicum*
Spores 55–74 x 5–7 μ, 7–11-septate; Colombia............ v. *granatense*
Spores 42–58 x 4–5 μ, 6–9-septate; Brasil................ v. *brasiliense*
Spores 36–50 x 7 μ, only 5-septate..................... *C. leucocarpum*
Apothecia not white-pruinose.
Spores 48–66 x 6–8 μ; Colombia....................... *C. implicatum*
Spores 38–50 x 6–8 μ; Chile............................ *C. chilenum*
Spores 40–45 x 5–6.5 μ; apothecia sessile, margins turgid; Mexico... *C. turgidulum*
Spores 30–37 x 2.5–3 μ; apothecial margins thin, blackening; Brasil.. *C. baculiferum*

COLLEMODIOPSIS Vainio, Étude Lich. Brésil 1: 234. 1890.
Type species: *Collema nigrescens* (Huds.) DC.

Spores slender, several-celled phragmospores, never muriform, apothecia with a pseudoparenchymatous cortex.

This subgenus is typically northern in its distribution. Only *C. lherminieri* Hue from Guadeloupe has been described previously from the American tropics.

COLLEMA (COLLEMODIOPSIS) **Granadillae** Dodge, sp. nov.

Type: Costa Rica, Guanacaste, H. Granadilla, *Dodge & Thomas 6576.*

Thallus irregulariter subpinnatifide lobatus, lobis tenuibus, ad 1 mm. latis, viridi-nigricans, superne elevato-rugosus verrucosusque ad subisidiosus, inferne reticulatim elevato-rugosus, cinerascens, ad 400 μ crassitudine, decorticatus, rhizinis destitutus. Apothecium planum, peltatum, basi constrictum, 0.5–1.0 mm. diametro metiens, omnino nigrum, margine verrucosa; amphithecium 150–250 μ crassitudine, pseudoparenchymatice corticatum, intus algis nostocaceis subrectis; parathecium grosse pseudoparenchymaticum, bene evolutum, 100–120 μ crassitudine inferne, attenuatum ad 25–35 μ superne; hypothecium hyphis tenuibus dense contextum, 25–30 μ crassitudine; thecium 150–170 μ altitudine, paraphyses arcte cohaerentes septati, cylindrici, filiformes, ad 1 μ diametro metientes, clavato-capitati; ascosporae octonae, polystichae, rectae, fusiformes vel aciculares, 5-septatae, 37–42 x 4–5 μ.

Thallus irregularly subpinnately lobed, lobes slender, about 1 mm. broad, dark greenish black, with elevated folds and wrinkles above with masses of small subisidiose warts, below reticulately deeply scrobiculate wrinkled, more or less ashy, about 400 μ thick, without cortex or rhizoids. Apothecium peltate with constricted base, plane, about 0.5–1 mm. in diameter, wholly black, margin verrucose; amphithecium 150–250 μ thick, corticate with several layers of pseudoparenchyma below, within the filaments of *Nostoc* more or less straight and loosely interwoven; parathecium of large-celled pseudoparenchyma, about 100–120 μ thick below, thinning above at the margin to 25–35 μ; hypothecium of densely woven slender hyphae, 25–30 μ thick; thecium 150–170 μ tall; paraphyses closely adherent, septate, cylindrical, filiform, about 1 μ in diameter, clavate, capitate at the apex; ascospores 8 per ascus, polystichous, straight, fusiform or acicular, 6-celled, 37–42 x 4–5 μ.

Guanacaste: H. Granadilla, *Dodge & Thomas 6576;* near Tilarán, *Standley & J. Valerio 44529*, 640–660 m., *Dodge & Thomas 6560.*

COLLEMA LEUCOPEPLA (Tuck.) Schneider, Guide Study Lich., 181. 1898.

Collema nigrescens var. *leucopepla* Tuck., Syn. N. Am. Lich. 1: 148. 1882.

Type: not stated in original description, based on material from South Carolina, Georgia, Florida, Alabama, and Louisiana.

It is probable that material collected in Puntarenas, Boruca, 560 m., *Tonduz 5373*, and determined by Müller Argau as *C. nigrescens* var. *caesium* Ach., belongs here but I did not have time to study it critically while I was in Genève. This species of the lower Atlantic and Gulf Coastal Plain in the United States has also been reported by Vainio from Mexico.

DICOLLEMA (Clements) Dodge, n. subgenus.

Dicollema Clements, Gen. Fung. 74. 1909.

Type species: *Collema pycnocarpum* Nyl.

Thallus narrowly laciniate or incised, spores clavate to fusiform, typically 2-celled, rarely 4-celled.

The material referred to the type species of this genus by different authors is quite variable and the whole group needs a thorough revision. Pending such a study, I am proposing several varieties of *C. pycnocarpum* Nyl. to cover the more conspicuous variations which seem to have separate geographical ranges, those with the smaller spore sizes being rather more southern in their distribution.

COLLEMA PYCNOCARPUM Nyl., Syn. Meth. Lich. 1: 115. 1858.

Type: United States [on journey from New York to Philadelphia], *Moré.*

Thallus dark or pale green, medium in size, granulate-nodose. Apothecia rufous, crowded, almost contiguous, at first plane, then somewhat convex, quite small, 0.5 mm. or a little larger; spores 8 per ascus, oblong or oblong-ellipsoid, simple or uniseptate, 14–17 x 4–5 μ.

Northern Atlantic Coastal Plain.

Var. **Minarum** Dodge, var. nov.

Collema pycnocarpum Vainio, Étude Lich. Brésil 1: 238. 1890.

Type: Brasil, Minas Geraes, Sitio, 1000 m., *Vainio 734.*

Sporae oblongae, ellipsoideae vel fusiformes, 1-septatae, 6–9 x 3 μ.

Var. **Malmei** Dodge, var. nov.

C. pycnocarpum Malme, Ark. f. Bot. **19**[8]: 7. 1924.

Type: Brasil, Rio Grande do Sul, Canõas near Porto Alegre, *Malme 536*.

Sporae oblongo-ellipsoideae vel ellipsoideae, uniseptatae, 10–14 x 3–4 μ.

Var. **crassiusculum** (Malme) Dodge, comb. nov.

Forma *crassiusculum* Malme, Ark. f. Bot. **19**[8]: 7. 1924.

Collema pycnocarpum Nyl., Acta Soc. Sci. Fenn. **7**: 428. 1863.

Type: Brasil, Matto Grosso, Corumbà, *Malme.*

Sporae ellipsoideae, utroque apice obtusae, raro acutae vel altero obtusae, altero acutae, 10–15.5 x 4–5.5 μ.

The specimens cited by Nylander from Colombia, Bogotá, 2600 m., *Lindig 2872*, have spores 10–14 x 4.5–5.5 μ.

COLLEMA CYRTASPIS Tuck., Proc. Amer. Acad. Arts & Sci. **5**: 387. 1862.

Type: no type mentioned in the original description.

Thallus deeply and irregularly lobed, verrucose, deep blue green, darkening on drying, verrucae much larger than in *C. pycnocarpum,* about 400 μ thick; algal layer about 100 μ thick, composed of coiled and tangled filaments of *Nostoc* imbedded in a gel, cells spherical, about 4 μ in diameter; medulla gelified, traversed by very loosely tangled hyphae about 2–3 μ in diameter and occasional straight filaments of *Nostoc.* Apothecia immersed in the verrucae when young, becoming plane or even convex, up to 2 mm. in diameter, margin slightly verrucose when young, practically disappearing as the apothecium becomes increasingly complex; amphithecium about 160 μ broad, of the same texture as the thallus; parathecium lacking; hypothecium filamentous, quite highly developed, about 40 μ thick, not conspicuously thinner toward the margins, hyphae 2–3 μ in diameter, very loosely woven; thecium about 80 μ tall; paraphyses filamentous, clavate, expanded above, imbedded in a gel; asci clavate, about 40 x 8 μ, 8-spored; ascospores subfusiform, 2–4-locular, 16–25 x 3–7 μ [16–20 x 4–4.5 μ in Costa Rican specimens].

This species is widely distributed in the southern Atlantic

and Gulf Coastal Plain in the United States, extending up the Mississippi Valley to Iowa.

Guanacaste: Liberia, 100 m., *Dodge & Thomas 8016, 8027.*

SYNECHOBLASTUS (Trevis.) Vainio, Étude Lich. Brésil **1:** 234. 1890.

Lathargium S. F. Gray, Nat. Arrang. Brit. Pl. **1:** 399. 1821, p. p.

Synechoblastus Trevis., Caratt. Tre Nuov. Gen. Coll. 3. 1853, p. p.

Type species: as subgenus based on *C. glaucophthalmum* Nyl.

Apothecia without pseudoparenchymatous cortex, spores fusiform to more or less acicular, many-celled, mostly over 30 μ long.

This subgenus is typically northern. Only two species are known from Costa Rica, where they are temperate species at elevations between 1000 and 1800 m., and are also found in the highlands of Colombia at somewhat greater altitudes.

COLLEMA GLAUCOPHTHALMUM Nyl., Syn. Meth. Lich. **1:** 114, 115. 1858.

Type: Mexico, Orizaba, *Fr. Müller.*

Thallus olivaceous-fuscous, medium size, expanded, more or less fenestrate and dissected, scrobiculate, and often granuliferous. Apothecia glauco-lilac colored, plane and somewhat concave, margin prominent, thin; ascospores 77–92 x 6–7 μ.

Var. GRANATENSE Hue, Jour. de Bot. [Morot] **20:** 12. 1906.

Collema glaucophthalmum Nyl., Acta Soc. Sci. Fenn. **7:** 428. 1863, non loco alio.

Type: Colombia, Choachí, 2600 m., *Lindig 813.*

Thallus dusky yellowish green to almost black, irregularly lobed and fenestrate, smooth or somewhat scrobiculate, coarsely wrinkled and subverrucose, especially toward the tips, margins thick and rounded, 800–1000 μ thick, homoeomerous, of loosely tangled filaments of *Nostoc*, cells 5–6 x 2.5–3 μ, ellipsoidal. Apothecia peltate, constricted at the base, up to 3 mm. in diameter, margin at first prominent, smooth, becoming thinner, less prominent and verrucose at maturity; disc chalky white to vinaceous-russet; amphithecium about 160 μ thick, homogeneous with the thallus; parathecium pseudoparenchymatous, 40 μ thick, thinning to 20 μ or even disappearing above at the margin;

hypothecium filamentous, of large very densely interwoven hyphae about 40 μ thick; thecium about 120 μ tall; paraphyses filiform, about 1 μ in diameter, not swollen above; asci clavate, about 20 μ in diameter, 8-spored; ascospores polystichous, fusiform to acicular, 55–74 x 5–7 μ.

The whiteness of the apothecial disc is very variable on the same thallus, in general being more pronounced on young and rapidly growing apothecia and gradually disappearing on older and more exposed ones. It seems to be a semi-crystalline deposit which slowly dissolves away, disclosing the vinaceous-russet disc formed by the discoloration of the upper portion of the gel surrounding the paraphyses. This variety has previously been reported only from Colombia.

Cartago: near R. Birrís above Santiago, 920–1340 m., *Dodge 8011*, *Dodge & Thomas 8015;* Carpintera, 1700 m., *K. Danielson 102.*
San José: Sta. María de Dota, 1500–1800 m., *Standley & J. Valerio 44150.*

COLLEMA IMPLICATUM Nyl., Acta Soc. Sci. Fenn. 7: 428. 1863.

Type: Colombia, Villeta, 1100 m., *Lindig 749;* Cundinamarca, Bogotá, 2400–2600 m., *Lindig.*

Thallus dark greenish black, broadly lobed and fenestrate, smooth near margins, becoming deeply reticulate-scrobiculate in older portions of the thallus, verrucae scattered, more elevated, often subisidioid, margins thin and semipellucid, homoeomerous, of loosely tangled filaments of *Nostoc,* cells 4 x 5 μ, heterocysts 5 x 8 μ, much more closely tangled in an outer zone about 150 μ thick. Apothecia peltate, constricted at the base, up to 4 mm. in diameter, margin at first prominent, verrucose, becoming thinner, less prominent, scarcely visible as the apothecium becomes expanded and convex, disc cameo-brown, without pruina in young apothecia; amphithecium about 100 μ thick, homogeneous with the thallus; parathecium pseudoparenchymatous, about 80 μ thick below, thinning out to a single layer of thick-walled cells 6 μ wide above at the margin; hypothecium of densely woven hyphae about 20 μ thick; thecium about 100 μ tall; paraphyses about 2 μ in diameter, with clavate brown tips; asci clavate, 8-spored, 12–16 μ in diameter; ascospores polystichous, fusiform to acicular, 48–66 x 6–8 μ, 7–9-septate.

This species is very closely related to *C. glaucophthalmum*

and has been reduced to synonymy by some authors. It differs from the previous species in several minor details of proportion of measurements and in the lack of a well-developed pruina. It is to be hoped that some one will be able to study the two forms in the field to determine the constancy of this character. In a series of specimens one can find considerable variation in the amount of pruina in *C. glaucophthalmum.* It should be noted that the two species occupy the same areas in Costa Rica.

Cartago: above R. Birrís at Santiago, 1140–1180 m., *Dodge 8017;* Carpintera, 1700 m., *K. Danielson 101c.*

The following species has not been found in Costa Rica but it is closely related to this group.

COLLEMA (SYNECHOBLASTUS) **Ramboi** Dodge, sp. nov.

Type: Brasil, Rio Grande do Sul, Porto Alegre, *B. Rambo 74.*

Thallus parvus, adscendens, obscure viridi-nigricans, angustilobatus, fenestratus clathratusque, verrucis elevatis isidioideis, marginibus plus minusve integris, tenuibus, pellucidis, 130–140 μ crassitudine, homoeomerus, filamentis nostocaceis laxe implexis, in zona exteriori 40 μ crassitudine dense contextis, cellulis ad 3 x 6 μ. Apothecium peltatum, basi constrictum, planum, 0.5–0.6 (– 1.0) mm. diametro, margine tenui, verrucosa subcrenulatave, disco obscure castaneo nigroque; amphithecium 20 μ crassitudine, cum thallo homogeneum; parathecium deest; hypothecium 20 μ crassitudine, hyphis tenuibus dense contextum; thecium 160 μ altitudine; paraphyses filiformes, ad 1 μ diametro, apicibus inflatis; asci clavati, 120 x 8–10 μ; ascosporae octonae, polystichae, aciculares, immaturae, plus quam 100 μ longitudine, multiloculares.

Thallus small, elevated, dark greenish black, narrowly lobed and fenestrate, verrucae elevated and isidioid, margins more or less smooth, thin, pellucid, 130–140 μ thick, homoeomerous, of loosely tangled filaments of *Nostoc*, cells about 3 x 6 μ, much more closely tangled in an outer zone about 40 μ thick. Apothecia peltate, constricted at the base, 0.5–0.6 (– 1.0) mm. in diameter, plane, margin very thin, verrucose, subcrenulate, finally almost disappearing while the expanded apothecium remains plane, disc dark chestnut to black; amphithecium 20 μ broad, homogeneous with the thallus; parathecium absent; hypothecium 20 μ

thick, of slender densely woven hyphae; thecium about 160 μ tall; paraphyses filiform, about 1 μ in diameter with greatly swollen tips, imbedded in a hymenial gel; asci clavate, 8-spored, 120 μ long, 8–10 μ wide; ascospores polystichous, 8 per ascus, acicular, immature and very difficult to measure but somewhat more than 100 μ long, many-celled.

LEPTOGIUM S. F. Gray

Leptogium S. F. Gray, Nat. Arrang. Brit. Pl. **1**: 400. 1821.

Type species: *Leptogium tremelloides* S. F. Gray, excl. syn.

Thallus foliose in the tropical species, gelified, below naked (covered with rhizinae in section *Mallotium*), with pseudoparenchymatous cortex above and below, algae *Nostoc*. Apothecia sunken in the thallus at first, emerging and often short-stipitate; amphithecium often corticate with several layers of pseudoparenchyma below, usually of a single layer above; parathecium usually present and pseudoparenchymatous, often thinning out above at the margin, sometimes of large, more or less parallel hyphae; paraphyses simple and filiform, often with apex variously thickened; asci clavate to cylindrical, 8-spored; ascospores usually imbricately monostichous, occasionally distichous, hyaline, usually broadly fusiform with acute to acuminate ends (acicular in section *Leptogiopsis*), usually muriform (except in *Leptogiopsis*), with thin walls.

Four of the seven sections into which *Leptogium* is divided are found in tropical America, all four of them in Costa Rica. *Leptogiopsis* differs from all the other sections in its acicular, never muriform spores, and perhaps should be treated as a separate genus, more or less related to section *Synechoblastus* of *Collema*. It is endemic in tropical America, with a single unidentifiable fragment yet found in Costa Rica. *Mallotium*, to which may also be referred the section *Leptolobaria* of Vainio based on *L. callithamnium* from Chile and the Antilles, has highly developed rhizinae below, and often more or less tomentum above, especially in the vicinity of the apothecia. It is widespread in its distribution, being found in the temperate zones and evidently preferring the colder regions of the tropics, not occurring below about 1300 m., in Costa Rica not seen below 3000 m. *Diplothallus*, with

its two separate layers of thallus, each with its own cortex, connected by pillars of pseudoparenchyma which on drying cause punctate depressions in the thallus, is endemic in tropical America and confined to the temperate regions, in Costa Rica occurring between 1200 and 1700 m., coming down to lower levels in the mountain near H. Santamaría of the Cordillera de Tilarán in Guanacaste. *Euleptogium,* which contains the most species, is found from sea level to about 1800 m. in Costa Rica, although most of the species of this section have a narrower altitudinal range. The lowland species ascend the river valleys but mostly drop out at about 1000 m. These are usually widespread at low elevations, extending from the Atlantic and Gulf Coastal plains of the United States to southern Brasil and Paraguay. The species of the temperate region of Costa Rica are mostly confined to the mountains from southern Mexico to the northern Andes and the mountains of eastern Brasil.

The morphology of the apothecium is not altogether clear and considerable confusion exists in the nomenclature of the various parts. In the following discussion, I have treated the tissue, usually well differentiated, underlying the hypothecium, as the parathecium, whether it extends to the surface of the thecium or not and whether or not it is pseudoparenchymatous. In a very few species the parathecium as thus defined thins out and disappears near the edge of the thecium, and the hyphae of the hypothecium extend up to the surface of the thecium. It is possible that some would prefer to regard the parathecium as formed of two layers, the lower of which is pseudoparenchymatous and the upper filamentous, with only the upper extending to the surface of the thecium. The amphithecium (thalline margin of earlier lichenologists) is essentially homogeneous and continuous with the thallus, although the algae are sometimes more densely tangled and in many species the cortical cells on the under side of the amphithecium (morphologically continuous with the upper surface of the thallus) or even the under side of the thallus below the apothecium, may proliferate, forming a pseudoparenchyma of several layers of cells sometimes even thicker than the algal zone.

KEY TO THE TROPICAL AMERICAN SPECIES OF LEPTOGIUM

Spores acicular, never muriform.
  Thallus reticulate-scrobiculate; French Guiana. [Spores 6-celled, 35 x 10 μ, teste Leighton, in specimen from Amazonas, Brasil] .... *L. reticulatum*
  Thallus not reticulate-scrobiculate.
    Spores 48 μ long, 8–10-celled; Florida .... *L. fusisporum* (Tuck.) Dodge
    Spores 50–60 x 7–8 μ, 10–12-celled; Mexico .... *L. adpressum*
    Spores 65–85 x 3.5–5 μ, 10–12-celled; Brasil .... *L. megapotamicum*
Spores muriform.
  Thallus of two lamellae, each with its own cortex, attached to each other by columns of tissue .... DIPLOTHALLUS
    A single species .... *L. diaphanum*
  Thallus of a single lamella, not as above.
    Thallus with a thick tomentum of rhizinae below .... MALLOTIUM
      Apothecia on lower surface, lobes of thallus broad, imbricate .... *L. resupinans*
      Apothecia on upper surface.
        Upper surface of thallus tomentose, at least near apothecia.
          Margins of sinuses inrolled, lobes medium, sinuate; apothecial margins microphylline .... *L. inflexum*
          Margins of thallus isidiose dissected.
            Upper surface of thallus subglabrous and more or less granular-papillate .... *L. papillosum*
            Upper surface of the thallus arachnoid-tomentose, lobes minutely dissected, not otherwise isidiose; Chile. *L. callithamnium*
            Upper surface of thallus glabrous except in the vicinity of the apothecia; apothecial margin isidiose, scattered groups of isidia sometimes on the upper surface of the thallus. .... *L. inflexum* v. *isidiosulum*
    Thallus corticate with a single layer of cells on both surfaces, without rhizinae ....EULEPTOGIUM
      Thallus scrobiculate.
        Margin of thallus papillate-denticulate, olivaceous, thallus deeply reticulate-scrobiculate; parathecium filamentous; spores 22–24 x 12–14 μ .... *L. olivaceum*
        Margin of thallus smooth, thallus plumbeous.
          Thallus deeply reticulate-scrobiculate; spores 30–40 x 12–16 μ. .... *L. foveolatum*
          Thallus shallowly scrobiculate; spores 20–30 x 8–10 μ... *L. microstictum*
      Thallus variously wrinkled on drying, but not scrobiculate, usually nearly smooth when moist.
        Apothecia on tips of long swollen processes of the thallus.
          Thallus lobes narrow, dichotomously branched, wrinkles irregular .... *L. stipitatum*
          Thallus lobes broader, not conspicuously dichotomously branched, wrinkles predominantly longitudinal or radial, secondary wrinkles mostly periclinal to margins.
            Apothecia radially wrinkled to smooth; spores 23–32 x 10–13 μ .... *L. vesiculosum*
            Apothecia with periclinal wrinkles, foliolate or isidiose.
              Thallus and apothecia not isidiose.

Apothecia small, spores 22–30 x 10–12 μ, margin wrinkled.
Thallus lobes broad........................*L. phyllocarpum*
Thallus lobes narrower, margins crisped...........v. *campestre*
Apothecia rather large with more or less foliolate margins.
....v. *macrocarpum*
Thallus and apothecia isidiose, often densely so; spores 30–40(–45) x 12–17 μ........................*L. coralloideum*
Apothecia marginal, sessile or on short solid stalks, very minute.
Thallus dark green to black, exciple isidiose [spores 24–30 (–33) x 12–14 μ, transverse septa 5, fide Malme]; Jamaica..................................*L. chloromelan*
Thallus ashy to plumbeous.
Exciple isidiose, parathecium 150 μ thick; thecium 150–180 μ tall...............................*L. marginellum*
Exciple verruculose, parathecium 100 μ thick; thecium 120–140 μ tall; Paraguay.................*L. pilcomayense*
Exciple crenulate, parathecium 30 μ thick; thecium 110–130 μ tall; Paraguay......................*L. microcarpum*
Apothecia scattered on upper surface of the thallus.
Thallus thick, 250 μ or more, roughened below by more or less conical outgrowths but rhizinae absent.
Smooth above or slightly wrinkled, lobes ascending, obovate; Mexico...........................*L. hypotrachynum*
Reticulately wrinkled above, lobes appressed, short, wide, margins sometimes crisped; Brasil..........*L. mattogrossense*
Smooth or only slightly wrinkled below.................*L. sessile*
Thallus thinner, seldom reaching 200 μ.
Thallus more or less isidiose.
Isidia blackening, cylindric; parathecium well developed.
Spores 18–23 x 8–10 μ, transverse septa 3, rarely 5; Brasil and Paraguay........*L. pichneum* Malme excl. syn.
Spores 22–30 x 11–13 μ, transverse septa 5..........
...........................*L. simplicius* v. *pichneoides*
Isidia concolorous, parathecium not well developed.....
..................................*L. denticulatum* Nyl.
Thallus 100 μ thick; apothecia not isidiose; spores 22–27 x 7–9 μ, transverse septa usually 5; isidia coralloid branched or somewhat flattened; Brasil.
...................*L. austroamericanum* (Malme) Dodge
Thallus about 30 μ thick; apothecial margins verrucose, spores 16–23 x 8–9 μ, transverse septa 3; isidia often flattened and microphylline..............
.....................*L. denticulatum* Malme non Nyl.
Isidia of hemispheric concolorous granules, thallus rigid, irregularly undulate, wrinkled toward the margin; Paraguay.................................*L. granulare*
Thallus not isidiose.
Parathecium filamentous, or, if pseudoparenchymatous, very thin and inconspicuous.

Cortex of amphithecium a single layer of cells; thallus 50–75 μ thick; apothecia rarely 1 mm. in diam.; spores 15–19 x 6–8 μ with 3 transverse septa; Brasil . . . . *L. Puiggarii*

Cortex of amphithecium a single layer of cells above, becoming thick, pseudoparenchymatous below; apothecia 1–3 mm. in diam.

Thallus greenish black, 80–100 μ thick; spores 15–22 x 6–8 μ, with 3–5 transverse septa; Brasil . . . *L. brasiliense*

Thallus ashy, plumbeous, or bluish.

Thallus papulose and wrinkled above, opaque, 130–160 μ thick; spores 20–30 x 7–12 μ . . *L. pulchellum*

Thallus minutely wrinkled above, opaque, 150–170 μ thick; spores 24–28 x 12 μ . . . . *L. Standleyi*

Thallus minutely wrinkled above, margins inrolled; spores 38–46 x 16–18 μ . . . . *L. dimorphum*

Thallus smooth or minutely wrinkled on drying, pellucid, less than 100 μ thick.

Spores 22–28 x 8–10 μ; thecium 120–150 μ tall; thallus 80–100 μ thick . . . . *L. azureum*

Spores 18–22 x 10–12 μ, with 3–5 transverse septa; thecium 90–120 μ tall; thallus 35–60 μ thick . . . . *L. Tuckermani*

Spores 18–24 x 8–9 μ with 3–5 transverse septa; thecium 140–160 μ tall; thallus 35–50 μ thick; Brasil . . . . *L. Schiffneri*

Parathecium pseudoparenchymatous.

Spores 35–40 x 16–20 μ; thallus plumbeous to greenish; amphithecium smooth; Bolivia . . . . *L. laevius* (Nyl.) Dodge

Spores 30–40 x 12–17 μ; thallus rather dark plumbeous to black.

Laciniae 1–1.5 mm. broad, apothecia not over 1.5 mm. in diam.; thecium 170 μ tall; paraphyses 1.5–2 μ thick; Brasil . . . . *L. Lafayetteanum*

Laciniae up to 8 mm. broad, apothecia 1–2.5 mm. in diam.; thecium 190–220 μ tall; paraphyses 2.5–3 μ thick; Brasil. . . . . *L. pachycheilum*

Spores 25–35 x 12–15 μ; apothecia 1–2.5 mm. in diam.; thecium 150–180 μ tall; paraphyses 2–2.5 μ thick; Brasil . . . . *L. ulvaceum* Malme non Pers.

Spores 22–30 x 11–13 μ; apothecia 1.5–2.2 mm. in diam.; thecium 150–170 μ tall . . . . *L. simplicius*

Spores 18–34 x 9–15 μ; thallus dark green to plumbeous; amphithecium granulate to wrinkled.

Thalline lobes ascendant, gyrose-plicate . . *L. conchatum* (Tuck.) Dodge (*L. chloromelan* auct. non Sw.)

Thalline lobes narrower, edges erect, crisped. *L. stellans* (Tuck.) Dodge

DIPLOTHALLUS Vainio, Étude Lich. Brésil 1: 222. 1890.
Thallus of two lamellae connected by pillars. Each lamella

has a cortex of a single layer of isodiametric cells above and below, drying impressed-punctate. Rhizinae absent, spores muriform.

LEPTOGIUM DIAPHANUM (Sw.) Mont., Ann. Sci. Nat. Bot. III, **10**: 134. 1848.

Lichen diaphanum Sw., Nov. Gen. Sp. Pl. Prodr. 147. 1788.

Parmelia diaphana Ach., Meth. Lich. 223. 1803.

Collema diaphanum Ach., Lichenog. Univ. 654. 1810.

Leptogium punctulatum Nyl. ap. Fournier, Mexic. Pl. **1**: 1. 1872.

Leptogium tremelloides var. *impressopunctatum* Tuck. ap. Williams, Amer. Nat. **29**: 482. 1895.

Type: Jamaica, *Swartz*, in Riksmuseet, Stockholm, carefully described by Malme, Ark. f. Bot. **19**^{8}: 27. 1924.

Thallus mineral gray, lobes rounded, ascending, crowded, impressed-punctate, otherwise quite smooth, consisting of two layers, each about 40 μ thick, composed of a row of pseudoparenchymatous cells about 8 μ in diameter on each surface and an algal layer of *Nostoc* between, the layers connected by pseudoparenchymatous pillars whose contraction in drying form the depressions. Apothecia borne on the upper layer, peltate, constricted at the base, 1–1.5 mm. in diameter, margin light buff, smooth, disc chestnut; amphithecium corticate with thick pseudoparenchyma below, about 80 μ thick, thinning to two layers of cells above next the disc, algal layer about 30 μ thick below the thecium; parathecium absent; hypothecium of densely woven, large, thick-walled hyphae about 50 μ thick; thecium 120–130 μ tall; paraphyses filiform, 1–2 μ thick, with clavate tips, forming a brown epithecium imbedded in a gel; asci clavate to cylindric, about 12–16 μ in diameter, thin-walled tips thickened and staining deep blue with iodine; spores 8 per ascus, imbricately monostichous, fusiform, muriform, 16–25 x 7–8 μ, with 3–5 transverse septa.

This species is found in the mountains from Mexico and the West Indies, Dominican Republic, and Jamaica (900–1200 m.) to Minas Geraes (1400–1500) m., Bolivia (1900 m.), and Perú (1700 m). In Costa Rica it is found from 1200 to 1700 m. and descends to 800 m. on the mountain back of the farmhouse at

H. Santamaría where the peculiar weather conditions enable many species to flourish below their normal altitudes. Apparently it needs high humidities as it is found mostly in localities of frequent and long-continued fogs (see p. 379).

Cartago: R. Birrís above Santiago, 1220–1340 m., *Dodge & Thomas 7938;* Cartago, *R. Torres R. 143;* Carpintera, 1700 m., *K. Danielson 103.*

San José: Sta. María de Dota, 1500–1800 m., *Standley & J. Valerio 43208.*

Heredia: C. Central de Zurquí, 1600–1700 m., *Dodge, J. Valerio & Thomas 4624.*

Guanacaste: H. Santamaría, 720–850 m., *Dodge, Jiménez & Thomas 7017.*

Mallotium Ach., Lich. Univ. 644. 1810.

Mallotium Gray, Nat. Arrang. Brit. Pl. **1**: 399. 1821.

Type: *Collema saturninum* (Dicks.) Ach.

Thallus foliose, cortex of pseudoparenchyma above, below tomentose with rhizinae; spores muriform.

This subgenus, considered as a separate genus by many authors, is cosmopolitan in distribution, mostly along cold foggy coasts or in mountains, being abundant in species in northern Europe and in Patagonia, Tierra del Fuego, and Antarctic Islands. Our tropical species seem confined to much higher elevations (above 1800 m. in Costa Rica) than the other members of *Leptogium.* It is quite distinct in appearance, often tomentose above, so that sterile specimens might be taken for *Erioderma* or *Umbilicaria* on macroscopic examination.

Our two species, *L. inflexum* and *L. papillosum,* are both Mexican, the former extending to Perú, the latter not known south of Costa Rica.

Leptogium **papillosum** (Bouly de Lesdain) Dodge, comb. nov.

Leptogium Hildenbrandii var. *papillosum* Bouly de Lesdain, Lich. Mexique, 30. 1914.

Type: Mexico, Michoacan, Puebla, H. Batan, *G. Arsène Brouard 4212;* Morelia, C. Azul, *G. Arsène Brouard 3999.*

Thallus mineral gray above, dark olive buff below, lobes subpinnatifid, with small, lacerate, almost isidioid margins, papillate-granulose, sometimes isidiose above, densely tomentose below, algal layer about 60 μ thick, corticate on each surface, with cells 5–6 μ in diameter, the cortex of the lower surface giving rise to a dense covering of rhizinae. Apothecia submarginal but too immature in our specimens to show details of structure well.

San José: L. de la Chonta, n. e. Sta. María de Dota, 2000–2100 m., *Standley 42285;* near Sta. María de Dota, 1500–1800 m., *Standley 41643.*

LEPTOGIUM INFLEXUM Nyl., Flora **41:** 377. 1858; Syn. Meth. Lich. **1:** 132. 1858.

Type: Mexico, Orizaba, *Fr. Müller.*

Thallus deep glaucous gray, dark olive buff below, lobes irregular, rounded, margins crisped and subascending, smooth above except in the vicinity of the apothecia, densely tomentose below, algal layer about 60 μ thick, corticate on both sides with two layers of cells about 8–10 μ in diameter, the lower surface giving rise to rhizinae, as also the outer cortical cells in the vicinity of the apothecia. Apothecia large, up to 4 mm. in diameter, margin more or less tomentose below, phyllophorous, concolorous with the thallus, disc orange rufous to auburn, edge of parathecium lighter; amphithecium with pseudoparenchymatous cortex about 100 μ thick, thinning to about one or two cells thick above, algal layer of *Nostoc* about 80 μ thick; parathecium pseudoparenchymatous, about 20 μ thick below the hypothecium, expanding upward to thickness of 100 μ above; hypothecium 30 μ thick, of densely woven hyphae; thecium 240 μ tall; paraphyses filiform, 1–2 μ in diameter, with swollen clavate tips forming a brown epithecium; asci 20–25 μ in diameter, cylindrical; ascospores monostichous, 8 per ascus, broad, fusiform, muriform, with 7 transverse septa, about 35–40 x 13–17 μ.

Superficially the thallus suggests the texture of *L. tremelloides*, while the apothecia might easily be mistaken for *L. phyllocarpum*, although the rhizinae below should be easily observed.

Cartago: F. Volcán de Turrialba, 2000–2400 m., *Standley 34966, 35174.*

San José: Quebradillas, 7 km. n. Sta. María de Dota, *Standley 42899;* C. de las Vueltas, 2700–3000 m., *Standley & J. Valerio 43823a.*

Var. ISIDIOSULUM Nyl., Acta Soc. Sci. Fenn. **7:** 429. 1863; Ann. Sci. Nat. Bot. IV, **19:** 289. 1863.

Type: Colombia, Paramo Choachí, 3600 m., *Lindig.*

This variety differs in the thallus being partly isidio-furfuraceous, especially the margins of the lobes; apothecial margin isidiose instead of phyllophorous, subnude below; spores 36–44 x 18–25 μ.

This variety would seem to differ from *L. papillosum* in that the isidia are in scattered groups or marginal, much more highly

developed and more denuded below. A single sterile specimen has been referred here.

San José: C. Zurquí, 2000–2500 m., *Standley & J. Valerio 48292.*

Euleptogium Tuck., Gen. Lich. 95. 1872.

Stephanophorus Fw., Linnaea **17**: 29. 1843.

Type species: no species cited.

Thallus foliose, monophyllous, without rhizinae, upper and lower cortex present, each of a single layer of isodiametric cells; spores muriform, many-celled.

This subgenus is predominantly tropical with many species in tropical America.

Leptogium olivaceum (Hook.) Zahlbr., Cat. Lich. Univ. **3**: 146. 1924, excl. syn.

Collema olivaceum Hook. ap. Kunth, Syn. Pl. Aequinoct. Orb. Nov. **1**: 38. 1822.

Type: Colombia, Cauca, between Popayan and Almaguer, *Humboldt 252.*

Thallus isabella to light brownish olive, lobes broad and rounded, surface deeply reticulate-scrobiculate with sharp ridges and margins granulate-isidiose, or ridges rarely microphylline; about 200 μ thick, corticate above and below with an algal layer of loosely tangled filaments of *Nostoc* corresponding to a medulla, separated from the cortex by a palisade layer about 30 μ thick. Apothecia sessile, margin verrucose, concolorous, disc darker; amphithecium thick, homogeneous with the thallus; parathecium about 80 μ thick, of very densely woven hyphae; hypothecium about 25 μ thick, very deeply staining; thecium about 100 μ tall; paraphyses filiform, about 1.5 μ in diameter, ending in the epithecial gel.

The apothecia are very rare and too immature in the one specimen from Costa Rica to give all the characters, but it seems quite distinct from *L. reticulatum* and *L. foveolatum.*

Cartago: R. Reventazón below Santiago, 740–750 m., *Dodge 8010.*

Var. **granulosum** Dodge, var. nov.

Type: Costa Rica, San José, R. Virilla below El Brazil, *Dodge 8030.*

Thallus similis speciei sed nigro-granulatum ambobus superficiebus. Apothecia obscure brunnea, nigricantia, sessilia, basi

constricta, disco concolore; amphithecium 190 μ crassitudine, corticatum cellulis isodiametricis; parathecium 130–140 μ crassitudine, ad marginem 40 μ attenuatus, hyphis dense contextum; hypothecium 30 μ crassitudine; thecium 120–130 μ altum; paraphyses similes speciei; asci 12–16 μ diametro metientes; ascosporae imbricatim monostichae, octonae, fusiformes, 22–24 x 12–14 μ.

Thallus similar to that of the species but black-granulate on both surfaces. Apothecia dark brown, blackening, sessile, constricted at the base, disc concolorous; amphithecium 190 μ thick, homogeneous with the thallus, corticate with a single layer of isodiametric cells; parathecium 130–140 μ thick, thinning toward the margin to 40 μ, of densely woven hyphae; hypothecium 30 μ thick, so deeply staining that its structure is not clear; thecium 120–130 μ tall; paraphyses as in the species; asci cylindric, 12–16 μ in diameter; ascospores imbricately monostichous, 8 per ascus, fusiform, 22–24 x 12–14 μ.

San José: R. Virilla below El Brazil, *Dodge 8030.*

Leptogium foveolatum Nyl., Syn. Meth. Lich. 1: 124. 1858.

Type: not stated, specimens from Bolivia, *Weddell,* and Mexico, *Fr. Müller,* are mentioned.

Thallus mineral gray or darker, often discolored light yellowish olive or darker, lobes rounded, smooth, surface deeply foveolate with sharp wrinkles both above and below; very variable in thickness up to 250 μ, *Nostoc* very sparsely scattered throughout, rather denser and tending to form a palisade layer just below the surface, but this layer much thinner and less definite than in *L. olivaceum.* Apothecia about 1.5 mm. in diameter, constricted at the base, margin smooth, light buff, disc cinnamon rufous; amphithecium about 130 μ thick, similar to the thallus in structure but algae much more abundant and closely tangled and cortex pseudoparenchymatous, about 50 μ thick; parathecium about 40 μ thick below, thinning out and disappearing above, pseudoparenchymatous with small cells; hypothecium about 80 μ thick, very deeply staining; thecium about 170 μ tall; paraphyses filiform, about 2 μ in diameter, tips clavate; asci 8-spored, cylindrical, about 12 μ in diameter; ascospores imbricately

monostichous, 30–40 x 12–16 μ [only 20 x 10 μ in Costa Rican specimens, but obviously immature].

San José: R. Virilla below El Brazil, *Dodge 7783.*

LEPTOGIUM MICROSTICTUM Vainio, Dansk Bot. Ark. 4^{11}: 18. 1926.

Type: not stated, specimens cited, Mexico, Palenque, *Liebmann 7415, 7416, 7428;* Papantla, *Liebmann.*

Thallus light glaucous blue or a little darker, lobes rounded, surface smooth but irregularly impressed, margin thin and smooth; about 225 μ thick, corticate on both surfaces with cells about 4 μ in diameter, the filaments of *Nostoc* very loosely tangled, more or less parallel to the surface and very scanty in the middle. Apothecia 0.5–1.0(– 1.3) mm. in diameter, sessile, constricted at the base, margin thin, whole, concolorous with the thallus, disc pale to tawny; amphithecium about 60 μ thick, cortex pseudoparenchymatous, about 25 μ thick below, thinning out above to a double layer of cells, algal layer of tangled filaments of *Nostoc;* parathecium pseudoparenchymatous, about 40 μ thick, thinning above to about three layers of cells; hypothecium 30 μ thick, of densely tangled rather large hyphae suggesting pseudoparenchyma but cells much smaller than in the parathecium; thecium about 100 μ tall; paraphyses filiform, 1 μ in diameter, ending in the epithecial gel; asci clavate to cylindrical, 12–16 μ in diameter; ascospores distichous, 8 per ascus, fusiform, with about 5 transverse septa, 20–30 x 8–10 μ.

A single small specimen from Costa Rica is doubtfully referred here. The thallus is somewhat more finely impressed and occasionally near the margin it appears very minutely scrobiculate. This specimen is from a greater elevation than most other members of this subgenus.

San José: Guayabillos and Cabeza de Vaca, 2150–2350 m., *Dodge & Thomas 7418.*

LEPTOGIUM VESICULOSUM (Sw.) Malme, Ark. f. Bot. **19^{8}:** 14–15. 1924.

Lichen vesiculosus Sw., Nov. Gen. Sp. Pl. Prodr. 147. 1788.

Lichen bullatum Ach., Lichenog. Suec. Prodr. 137. 1798.

Leptogium bullatum Mont., Ann. Sci. Nat. Bot. II, **16:** 113. 1841.

Type: Jamaica, tops of mountains, *O. Swartz. L. bullatum* Ach. based on the same material.

Thallus plumbeous, lobes rounded, more or less appressed, longitudinally wrinkled with shallower cross ridges; about 100 μ thick between the ridges, corticate on each surface with a single layer of isodiametric cells, homoeomerous, of very loosely tangled filaments of *Nostoc* running more or less parallel to the surface. Apothecia sunk in the tips of podetiiform elevations of the thallus, margin wrinkled but not isidioid or phyllophorous, edge of parathecium conspicuous light buff, disc concave, rufous; amphithecium continuous with the thallus without differentiation, cortex a single layer of cells both above and below; parathecium 100 μ thick below, thinning out to 40–60 μ above at the margin, pseudoparenchymatous; hypothecium thick, 80 μ, of densely woven slender hyphae; thecium 120–140 μ tall; paraphyses slender, filiform, cells almost isodiametric above, disintegrating into the brown epithecial gel; asci cylindrical, 20 μ in diameter, 8-spored; ascospores imbricately monostichous, broadly fusiform, 23–32 x 10–13 μ, with 5 transverse septa.

This species seems to be widespread in the American tropics, from 700 to 2100 m., rarely also below these levels. *L. stipitatum*, with which this species is easily confused, seems confined to the lower levels, reaching up to about 800 m., and has so far only been reported from Guadeloupe and Costa Rica.

Limón: Waldeck, *Dodge & Nevermann 7938;* Marta, 20 m., *Dodge 7427.*

Cartago: Angostura, *Polakowsky 456;* Juan Viñas, 1000 m., *Calvert 68;* Santiago, 1140–1180 m., *Dodge 4555;* R. Birrís, 1220–1340 m., *Dodge & Thomas 4628;* Aguacaliente, 1240–1460 m., *Dodge & Thomas 7082;* Carpintera, 1700 m., *K. Danielson 101a.*

San José: S. Pedro de Montes de Oca, 1200 m., *Thomas 4717;* S. Juan Tibas, 1000–1100 m., *Dodge 4303.*

Guanacaste: H. Santamaría, 640–680 m., *Dodge & Thomas 6797.*

Puntarenas: Boruca, 560 m., *Tonduz 5380.*

Var. DIGITATUM Eschw. ap. Martius, Fl. Brasil. **1:** 238. 1833.

Collema bullatum Raddi, Atti Soc. Ital. **18:** 36, *pl. 4, f. 2.*

Collema bullatum var. *dactylinoideum* Nyl., Flora **41:** 338. 1858; Syn. Meth. Lich. **1:** 129. 1858.

Type: Brasil, between Mandiocca and Morro do Frade, *Raddi,* type of var. *dactylinoideum* not cited, but specimens from Mexico, *Fr. Müller,* Colombia, Tolima, *Goudot,* and Bolivia, *Weddell,* are mentioned.

This variety is stated by Eschweiler to have a thicker thallus,

deep green instead of lead color, densely wrinkled instead of granular; podetia cylindrical instead of ventricose, 6–12 mm. instead of 2–6 mm. tall, about 6 mm. in diameter.

From the description this variety does not seem distinct from the species and I have seen no material referable here from Costa Rica. It is possible that Eschweiler was attempting to separate this species from *L. phyllocarpum* which he called *Collema* (*Leptogium*) *bullatum* var. *sertatum*.

Leptogium stipitatum Vainio, Hedwigia 38: (255). 1899.

Type: Guadeloupe Island, near Gourbeyre, *P. Duss 434*.

Thallus plumbeous, soon discolored buffy citrine to Saccardo's olive, irregularly dichotomously branched, ultimate lobes 2–7 mm. broad, then crowded and confluent, rounded, acutely and irregularly wrinkled above and below; about 200 μ thick between the ridges, with *Nostoc* filaments densely coiled and tangled near the surface, mostly parallel to the surface within, much more abundant than in *L. vesiculosum*, with cortex of isodiametric cells on each surface. Apothecia on short thalline pustules, up to 2.5 mm. in diameter, margin thick with periclinal folds (never radial as in *L. vesiculosum*), disc chestnut; amphithecium about 200 μ thick, of the same texture as the thallus; parathecium 80 μ thick, disappearing above, of large-celled pseudoparenchyma; hypothecium 80 μ thick, of more or less parallel hyphae continued upward as a false parathecium; thecium about 140 μ tall; paraphyses filiform, about 1.5 μ in diameter, septate, with capitate tips in the brown epithecial gel; asci cylindrical, 16–20 μ in diameter; ascospores distichous, broad-fusiform with acute ends, 24–32 x 10–12 μ.

San José: cañon of R. Virilla, below El Brazil and Sta. Ana, *Dodge 8019*.
Puntarenas: Peninsula of Puntarenas, 3–5 m., *Dodge 8021*.

Leptogium phyllocarpum (Pers. ap. Gaudich.) Mont., Ann. Sci. Nat. Bot. III, **10**: 134. 1848.

Collema phyllocarpum Pers. ap. Gaudich. in Freycinet, Voy. Uranie, Bot. 204. 1826.

Collema bullatum var. *sertatum* Eschw. ap. Martius, Fl. Brasil. 1: 239. 1833.

Type: Brasil, Rio de Janeiro, *Gaudichaud*.

Thallus plumbeous but frequently becoming black, especially

in specimens which have been dried slowly or repeatedly wetted and dried after collection, lobes broad, surface deeply and acutely wrinkled, the wrinkles predominantly longitudinal or radial, the secondary wrinkles very irregular; more than 200 μ thick between the wrinkles, corticate on both surfaces by a single layer of isodiametric cells, the filaments of *Nostoc* loosely tangled, more or less parallel to the surface and much more coiled and densely tangled just under the upper cortex. Apothecia about 2 mm. in diameter, margin with crowded periclinal wrinkles, disc rufous, immersed in hollow protuberances as in *L. vesiculosum;* amphithecium appearing lobed in section up to 500 μ thick, homogeneous with the thallus but algae a little denser; parathecium about 100 μ thick below, thinning out to about 20 μ above at the margin, of large-celled pseudoparenchyma; hypothecium about 30 μ thick, of slender densely woven hyphae continuing up to the margin at about the same width; thecium about 140 μ tall; paraphyses filiform, not dilated above, epithecial gel brown; asci cylindric, about 20 μ in diameter, 8-spored; ascospores broad-fusiform with acute ends, monostichous, with 5 transverse septa, 22–30(–35) x 10–12(–14) μ.

Apparently this species is very widespread and common in the American tropics from low elevations in the southern United States to 2500 m. in Perú. In Costa Rica it ranges from 500 m. to about 1900 m., being characteristic in the moister fog-bathed areas of the temperate region.

Cartago: Santiago, 1140–1180 m., *Dodge 8000;* R. Birrís, 1220–1340 m., *Dodge & Thomas 7994.*

San José: Cañon of R. Virilla below El Brazil, *Dodge 7782;* Zapote, 1200 m., *Standley 40273;* La Palma, 1500–1700 m., *Maxon & Harvey 7891;* Quebradillas, near Sta. María de Dota, 1800 m., *Standley 42977;* Sta. María de Dota, 1500–1800 m., *Standley 42424;* S. Marcos de Dota, 1200 m., *Tonduz 5374;* R. Naranjo, *Tonduz 5375;* S. Gabriel, *Tristan 5229;* S. José, *Polakowsky 113.*

Alajuela: R. Ciruela, 920–980 m., *Dodge & J. Valerio 4858;* Santiago de S. Ramón, 1000 m., *Brenes;* Viento Fresco, 1600–1900 m., *Standley & Torres 47771.*

? Puntarenas: Corozal, 5–50 m., *Dodge 8025.*

Var. MACROCARPUM Nyl., Syn. Meth. Lich. 1: 130. 1858.

Type: not cited but specimens from Aequatorial America, *Humboldt*, Chile, Perú, and Venezuela, *Lind. 1092*, are mentioned.

Similar to the species but apothecia large, 5–9 mm., margins lobulate, foliose. American material referred to var. *daedaleum*

Nyl. probably belongs here. Distribution in Costa Rica essentially similar to that of the species but not yet collected in the higher elevations.

Cartago: Santiago, 1140–1180 m., *Dodge 8001;* R. Birrís, 1220–1340 m., *Dodge & Thomas 4632;* Carpintera, 1700 m., *K. Danielson 101b.*

San José: R. Naranjo, *Tonduz 5377.*

Alajuela: La Palma de San Ramón, 1250 m., *Brenes 91.*

Guanacaste: H. Santamaría, 640–780 m., *Dodge & Thomas 6776, 8002;* Tilarán, 500–690 m., *Standley & J. Valerio 44803, Dodge & Thomas 6562.*

Puntarenas: Corozal, 5–50 m., *Dodge 7529.*

Var. CAMPESTRE Malme, Ark. f. Bot. **19**^{8}: 13. 1924.

Type: Brasil, Bahia, R. Vermelho, *Malme 29, 30;* Matto Grosso, Cuyaba, *Malme 2715c,* etc.; Serra da Chapada, pr. Bocca da Serra, *Malme 2245B.*

Differs from the typical form by narrower crowded lobes, margins crisped; apothecia 1–2 mm. in diameter, margin rugulose, thin; amphithecium corticate with a single layer of cells; parathecium 60–70 μ thick, reaching the margin above; thecium 100–125 μ tall, asci up to 20 μ thick, 8-spored; ascospores irregularly distichous, broad-fusiform, acute ends, 22–27 x 8–10 μ, usually with 5 transverse septa.

San José: Turrúcares, 540–600 m., *Dodge & Thomas 7481.*

Alajuela: R. Ciruela, 920–980 m., *Dodge & J. Valerio 7921;* Santiago de S. Ramón, 1000 m., *Brenes.*

LEPTOGIUM CORALLOIDEUM Vainio, Ann. Acad. Sci. Fenn. A **6**^{7}: 110. 1915.

Leptogium diaphanum f. *coralloideum* Mey. & Fw., Nova Acta Acad. Leopold. Carolin. **19**: Suppl. 226. 1843.

Leptogium phyllocarpum var. *isidiosum* Nyl., Syn. Meth. Lich. **1**: 130. 1858.

Leptogium phyllocarpum var. *coralloideum* Hue, Nouv. Arch. Museum Paris III, **10**: 228. 1898.

The type of var. *isidiosum* is from Mexico, Orizaba, *Fr. Müller.*

Thallus as in *L. phyllocarpum* but densely isidiose, especially along the wrinkles, somewhat thicker, semi-pellucid. Apothecia large when present, very rare, margin densely coralloid-isidiose, disc rufous; amphithecium highly developed, homogeneous with the thallus; parathecium 140 μ thick, disappearing above, of large thin-walled pseudoparenchyma; hypothecium 60 μ thick, reaching the margin above, of densely woven slender hyphae;

thecium 200 μ tall; paraphyses filiform with clavate apices; asci cylindrical; ascospores 8 per ascus, imbricately monostichous, ellipsoid to fusiform, apices acute, 30–40(–45) x 12–17 μ, with 7 transverse septa.

This species is perhaps only a large isidiose variety of *L. phyllocarpum*, essentially similar in morphology but larger in most dimensions. It occupies the same general region as *L. phyllocarpum.* It is usually sterile and hence not easily distinguished from sterile *L. marginellum* var. *isidiosellum.* Material has been seen from Mexico, Perú, and Brasil.

Limón: Hamburg, 20–30 m., *Dodge 7420.*

Cartago: Pejivalle, 650–900 m., *Standley & J. Valerio, Dodge & Thomas 4337;* Cañon of R. Reventazón below Santiago, 920–1000 m., *Dodge & Thomas 8013, Dodge 8004;* R. Birrís, 1220–1340 m., *Dodge & Thomas 7954;* C. Carpintera, 1320–1700 m., *Dodge 3758, Dodge & Thomas 4762, K. Danielson 98;* Aguacaliente, 1240–1460 m., *Dodge & Thomas 8003;* R. Reventado, 1460–1650 m., *Standley & J. Valerio 49614.*

San José: R. Virilla below El Brazil, *Dodge 6496;* Zurquí, 1600–2500 m., *Standley & J. Valerio 48255, 48266, 48146, Dodge, J. Valerio & Thomas 6042.*

Alajuela: near Fraijanes, 1500–1700 m., *Standley & Torres 47425, 47462.*

Guanacaste: H. Santamaría, 640–680 m., *Dodge & Thomas 8005;* Tilarán, 500–650 m., *Standley & J. Valerio 44367, 44403.*

Leptogium marginellum (Sw.) S. F. Gray, Nat. Arrang. Brit. Pl. 1: 401. 1821.

Lichen marginellus Sw., Nov. Gen. Sp. Pl. Prodr. 147. 1788.

Collema vesicatum Taylor, London Jour. Bot. 6: 196. 1847.

Leptogium corrugatulum Nyl., Syn. Meth. Lich. 1: 132. 1858.

Type: Jamaica, Blue Ridge Mt., *Swartz.* The type of *C. vesicatum* Taylor is from St. Vincents, West Indies. The type of *Leptogium corrugatulum* is from Mexico, Jalapa, *Galeotti 9630.*

Thallus plumbeous, round-lobed, margin smooth or occasionally microphylline, pellucid, surface of undulating longitudinal wrinkles less acute than in *L. phyllocarpum,* of variable thickness, about 160 μ thick, corticate on both surfaces with small isodiametric cells. Apothecia minute, up to 0.3 mm. in diameter, margin densely isidiose, disc rufous; amphithecium thick, with pseudoparenchymatous cortex below, a single layer of cells above, as are also the isidia; parathecium 150 μ thick, pseudoparenchymatous; thecium 150–180 μ tall, epithecium tawny; asci 8-spored; spores imbricately monostichous, ellipsoid-fusiform, ends acute, 25–35 (–40) x 10–13 μ, with 5 transverse septa.

This species rarely matures spores although rudimentary apothecia are nearly always abundant. The microscopic details of the apothecium are largely taken from Malme as I have seen no mature asci in my Costa Rican material. There is considerable variation in the amount of isidia, as they easily break off leaving minute foveoles on the margin. The species is quite distinct and is widespread in the American tropics. I have seen material from Florida, Alabama, Bermuda, various islands of the West Indies, Mexico, Brasil, and the Galápagos Islands. It seems to range from sea level to 1500 m.

From the nature of the isidia it seems likely that var. *isidiosellum* Riddle, Brooklyn Bot. Gard. Mem. **1**: 115. 1918, should be referred to *L. coralloideum*, although sterile isidiose states are very difficult to place.

Limón: Marta, 20 m., *Dodge & Nevermann 7986;* Carmen, *Dodge 7422;* Waldeck, *Dodge & Nevermann 7421.*

Cartago: Pejivalle, 600–900 m., *Dodge & Thomas 8014, Standley & J. Valerio 46769;* R. Birrís, 920–1100 m., *Dodge 7988;* Santiago, 1140–1180 m., *Dodge 7987;* Aguacaliente, 1240–1460 m., *Dodge & Thomas 7937;* Carpintera, 1500 m., *Dodge 3948.*

Alajuela: Santiago de S. Ramón, 1000 m., *Brenes 242;* S. Pedro de S. Ramón, 700 m., *Brenes.*

Guanacaste: H. Santamaría, 640–720 m., *Dodge & Thomas 6867, 7989;* H. Granadilla, above R. S. José, 480 m., *Dodge & Thomas 7936;* H. Q. Azul, on lower slope of V. Tenorio, 400–600 m., *Dodge & Thomas 6653;* Tilarán, 500–690 m., *Dodge & Thomas 6561.*

Puntarenas: R. Terrones, 30 m., *Dodge & Marks 7980;* Corozal, 5–50 m., *Dodge 7533.*

Leptogium denticulatum Nyl., Ann. Sci. Nat. Bot. V, **7**: 302. 1867.

L. tremelloides v. *leptophyllinum* Mey. & Fw., Nova Acta Acad. Leopold. Carolin. **19**: Suppl. 228. 1843.

L. tremelloides v. *azureum* f. *isidiosum* Müll. Arg., Bull. Soc. R. Bot. Belg. **29**: 49. 1891, non Flora **65**: 292. 1882.

L. leptophyllinum Zahlbr., Cat. Lich. Univ. **3**: 136. 1924.

Type: Colombia, San Jil, 1300 m., *Lindig.*

Thallus mineral gray or darker, large, broadly lobed, lobes round, edges smooth, somewhat crisped, surface slightly wrinkled, 100–120 μ thick, microphylline, isidiose, corticate on both sides with a single layer of cells, the short filaments of *Nostoc* with cells 4–5 μ in diameter mostly assembled just under the cortex,

leaving the central portion relatively free of algae. Apothecia relatively rare but when present usually numerous, scattered over the upper surface, up to 2 mm. in diameter, margin granular, thick, becoming isidiose in age, buff, disc rufous; amphithecium 220 μ thick, with a layer of pseudoparenchymatous cortex below about 160 μ thick, not thinning out much above and merging with the parathecium, algal layer 60 μ thick below, thinning out to 30 μ above; parathecium 100 μ thick below, thinning out to about 40 μ above, of large thin-walled hyphae at times suggesting pseudoparenchyma; hypothecium 20 μ thick, of more slender deeply staining hyphae; thecium 160 μ tall; paraphyses slender, ending abruptly in the epithecial gel; asci 10–12 μ in diameter, cylindrical, 8-spored; ascospores imbricately monostichous, fusiform with acute ends and about 5 transverse septa, about 24 x 10 μ.

This species seems widespread in the American tropics, although it is so rarely fertile that it is difficult to be sure of the determination of much of the sterile material, especially to separate it from *L. cyanescens* var. *austro-americanum* Malme. As here described, this species is close to, although not identical with, Malme's variety, while the *L. denticulatum* Malme seems to be an isidiose state of or closely related to *L. Tuckermani*. Only a careful comparison of all the fertile specimens from tropical America in the various herbaria of Europe can settle these problems.

Limón: Marta, 20 m., *Dodge & Nevermann 7428;* Hamburg, *Standley & J. Valerio 48750;* Castilla, 20 m., *Dodge & Nevermann 7996;* Waldeck, *Dodge & Nevermann 7997*, *Dodge 8012.*

Cartago: R. Reventazón below Santiago, 740–750 m., *Dodge 4626*, 920–1000 m., *Dodge & Thomas 7993;* Santiago, 1100–1140 m., *Dodge 7939;* R. Birrís, 1220–1340 m., *Dodge & Thomas 7992;* Estrella, 1600 m., *K. Danielson 162;* near Cartago, 1500 m., *K. Danielson 22;* C. Carpintera, 1500 m., *Dodge 3973.*

San José: San José, *Tonduz 5247.*

Heredia: C. Zurquí, 1600–1700 m., *Dodge, J. Valerio & Thomas 8048.*

Alajuela: C. Mondongo de S. Ramón, 750–800 m., *Brenes 275;* Alto de la Palma de S. Ramón, 1250 m., *Brenes 377.*

Guanacaste: H. Santamaría, 680–780 m., *Dodge & Thomas 6870, 7014;* H. Granadilla above R. Las Cañas, 500–600 m., *Thomas 6623.*

Puntarenas: Osa, Corozal, 5–50 m., *Dodge 7998.*

LEPTOGIUM AZUREUM (Sw.) Mont. ap. Webb, Hist. Nat. Îles Canaries 3^1: 129. 1840.

Lichen azureum Sw. ap. Ach., Lichenog. Suec. Prodr. 137. 1798.

Type: mountains of Jamaica, *O. Swartz.*

Thallus pellucid, greenish-glaucous-blue to puritan gray, broadly sinuate-rounded lobes, smooth; margins smooth, 80–100 μ thick, of loosely coiled and tangled filaments of *Nostoc* with ellipsoidal cells 2.5 x 4 μ. Apothecia scattered, 1–2 mm. in diameter, margin smooth, light buff, disc rufous, sessile or on a short stalk; amphithecium 320 μ thick, below with a pseudoparenchymatous cortex about 100 μ thick, above with a single layer of isodiametric cells in the cortex; parathecium filamentous, 40 μ thick, poorly developed, of slender hyphae not reaching the margin; hypothecium 20 μ thick, deeply staining; thecium 120–150 μ tall; paraphyses filiform, 1.5–2 μ thick, thickened at the tips to about 4 μ; asci clavate-cylindrical, about 18 μ in diameter, 8-spored; ascospores imbricately monostichous or somewhat distichous, fusiform ends acute, with 3 or 5 transverse septa, 22–28 x 8–10 μ.

Only a careful study of all the types involved can settle nomenclature of the group of species centering around *L. tremelloides*. This species was originally collected in South Africa by Thunberg, and very briefly described by Linné fil. The early lichenologists of the west coast of Europe identified their material as this species and later reduced Swartz' Jamaican *L. azureum* to synonymy. There is apparently a whole group of species having approximately the same macroscopic appearance but wholly different microscopic structure which are at present referred to this species by various workers. As we have here defined it (agreeing closely with *L. tremelloides* Malme), it is a species of the lowlands coming up the river valleys under favorable conditions to about 1000 m. in Costa Rica. It seems widely distributed at lower elevations in tropical America.

Limón: Marta, 20 m., *Dodge & Nevermann 7414, 7426;* Hamburg, 20–30 m., *Dodge & Nevermann 7417;* Castilla, 20 m., *Dodge 7209, 7419, 7424;* Carmen, *Dodge 7415;* Indiana I. near Siquirres, 60–70 m., *Dodge & Thomas 5572;* along R. Siquirres, 70–350 m., *Dodge, Catt & Thomas 8006, 8007, 8008;* Livingston, 80–100 m., *Dodge, Catt & Thomas 5573;* Waldeck, *Dodge & Nevermann 7412, 7413, 7416;* Guápiles, 300–500 m., *Standley 37137.*

Cartago: Turrialba, *Ørsted;* R. Pejivalle, 650–800 m., *Dodge & Thomas 4414;* R. Reventazón, 920–1000 m., *Dodge & Thomas 4604.*

Guanacaste: H. Santamaría, 760–900 m., *Dodge & Thomas 6876;* Tilarán, 500–690 m., *Dodge & Thomas 8009.*

Puntarenas: Osa, C. Guaca, 85 m., *Dodge 7505;* Corozal, 5–50 m., *Dodge 7530.*

Isla Coco: *Snodgrass & Heller.*

LEPTOGIUM **Standleyi** Dodge, sp. nov.

Leptogium tremelloides Auct., non Linné fil.

Type: Costa Rica, La Hondura, *Standley 37870.*

Thallus plumbeus, crassus, laevis vel minute rugulosus, lobis rotundatis, latis, marginibus integris, 150–170 μ crassitudine, filamentis nostocaceis sub cortice dense implicatis, centro laxe aut sparse implicatis, corticatum e serie simplice cellularum. Apothecia ad 3 mm. latitudine, plana, margine integro, tenui, laevi, fulva, disco rufo; amphithecium inferne 160 μ, ad 100 μ crassitudine superne in margine attenuatum, cortice pseudoparenchymatico, 90 μ crassitudine inferne ad una serie cellularum superne attenuatum, filamentis nostocaceis dense contextum; parathecium 60 μ crassitudine, hyphis tenuibus dense contextum; hypothecium flavum, 20–30 μ crassitudine, hyphis tenuibus dense contextum; thecium ad 180 μ altitudine; paraphyses filiformes, tenues, apice non incrassata; asci cylindrici, 20 μ diametro metientes; ascosporae octonae, imbricatim monostichae vel distichae, fusiformes, 24–28 x 12 μ.

Thallus mineral gray or darker, thick, smooth or minutely and shallowly wrinkled, lobes broad, rounded, margins smooth, 150–170 μ thick, filaments of *Nostoc* densely tangled next the cortex, loosely tangled and scattered in the center of the thallus, cortex of a single series of cells on both surfaces. Apothecia 3 mm. broad, plane, margin smooth, thin, tawny, disc rufous; amphithecium 160 μ thick below, thinning to 100 μ above at the margin, corticate below, 90 μ thick, pseudoparenchymatous, above becoming a single layer of cells, filaments of *Nostoc* densely tangled; parathecium 60 μ thick, of slender more or less parallel hyphae; hypothecium yellowish, 20–30 μ thick, of slender densely woven hyphae; thecium 180 μ tall; paraphyses filiform, slender, apices not thickened; asci cylindrical, 8-spored, 20 μ in diameter; ascospores imbricately monostichous or distichous, fusiform, 24–28 x 12 μ.

This species is essentially close to *L. azureum* in its microscopic characters but differs in its much larger dimensions, its thicker,

opaque thallus, and larger apothecia. Superficially it somewhat resembles *L. pulchellum* but is much less coarsely wrinkled and differs in microscopic details. In Costa Rica it seems to be confined to the higher elevations reaching 1700 m. It is probable that material determined as *L. pulchellum* from Costa Rica by Müller Argau belongs here, although I did not have time to section it. It certainly is not typical *L. pulchellum*.

Cartago: Turrialba, *Ørsted;* Orosí, 1000–1100 m., *Standley 39791.*

San José: San José, 1130 m., *Standley 41233;* La Hondura, 1300–1700 m., *Standley 37870*, TYPE.

Alajuela: Poás, *Tonduz 5301.*

LEPTOGIUM **Tuckermani** Dodge, sp. nov.

Leptogium tremelloides var. *minor* Tuck. in herb.

? *Leptogium moluccanum* Vainio, Étude Lich. Brésil 1: 223–224. 1890, non *Collema moluccanum* Pers. ap. Gaudich. in Freycinet, Voy. Uranie, Bot. 203. 1826.

Type: Cuba, Monte Verde, *C. Wright 56.*

Thallus plumbeus vel obscurior, lobis confertis, rotundatis, superne inferneque sat laevigatus, tomento isidiisque destitutus, tenuissimus, 35–60 μ crassitudine, strato nostocaceo 25 μ, corticibus pseudoparenchymaticis cellulis magnis. Apothecium minutum, 0.5–0.9 mm. diametro metiens, peltatum, basi constrictum, margine integro, pallescente, disco castaneo; amphithecium corticatum cellulis pseudoparenchymaticis, 60 μ crassitudine inferne, attenuatum ad 12 μ superne, strato nostocaceo 40 μ crassitudine; parathecium pseudoparenchymaticum tenue, 10–12 μ crassitudine, cellulis parvis; hypothecium 20 μ crassitudine, hyphis tenuibus dense contextum; thecium 90–120 μ altitudine; paraphyses filiformes, 2 μ diametro, apicibus incrassatis; epithecium brunneum; asci cylindrici, 12 μ diametro metientes; ascosporae octonae, imbricatim monostichae, apicibus acutis, murales, septis transversalibus 3–5, cellulis haud numerosis, 18–22 x 10–12 μ.

Thallus mineral gray or darker, lobes crowded, more or less elevated and crisped, rounded, smooth on both sides, 35–60 μ thick, algal layer of *Nostoc* about 25 μ, with pseudoparenchymatous cortex above and below of large cells. Apothecia minute, 0.5–0.9 mm. in diameter, constricted at the base, margin whole, smooth, pale, disc chestnut; amphithecium with a thick pseudo-

parenchymatous cortex below, about 60 μ, thinning to two rows of cells about 10–12 μ thick above; parathecium thin, pseudoparenchymatous, 10–12 μ thick, of small cells, inconspicuous and often reported absent; hypothecium 20 μ thick, of slender densely woven hyphae; thecium 90–120 μ tall; paraphyses filiform, 2 μ in diameter, with clavate apices; epithecium brown; asci cylindric, 12 μ in diameter; ascospores 8 per ascus, imbricately monostichous, ends acute, muriform, with 3–5 transverse septa, cells not numerous, 18–22 x 10–12 μ.

This species has long been confused with *L. moluccanum*, *L. Mariannum*, and *L. diaphanum*. It differs from the two former in habit and color and from the latter by its structure. It is apparently widespread in the American tropics, being reported from Paraguay, and from Brasil in the states of Rio Grande do Sul and Matto Grosso by Malme, and in Minas Geraes by Vainio.

Limón: Hamburg, *Dodge 7425.*

Cartago: Pejivalle, 680 m., *Dodge & Thomas 4556;* Santiago, 1140–1180 m., *Dodge 4555, 8044;* Las Concavas, 1350–1450 m., *Dodge 6842.*

San José: hills above Sta. Ana, *Dodge 7781.*

Guanacaste: H. Santamaría, 680–780 m., *Dodge & Thomas 8043;* H. Granadilla, 480 m., *Dodge & Thomas 8045.*

LEPTOGIUM SIMPLICIUS Vainio, Ann. Acad. Sci. Fenn. **A6**^{7}: 109. 1915.

Type: S. Domingo, La Cumbra, *C. Raunkiaer.*

Thallus between light drab and light grayish olive, with irregularly incised lobes 5–7 mm. broad, not isidiose, with slightly undulate elevated acute wrinkles on both surfaces, corticate with a single layer of isodiametric cells. Apothecia broadly adnate, constricted at the base, sessile, 1.5–2.2 mm. in diameter, disc plane, rufous, margin thin, smooth, lighter than the thallus; amphithecium 140–150 μ thick, corticate with a single series of cells above, pseudoparenchymatous below, 90–100 μ thick; parathecium 120 μ thick below, thinning out to 20 μ thick at the margin above, pseudoparenchymatous; hypothecium filamentous, 30 μ thick; thecium 150–170 μ thick; paraphyses filiform, tips somewhat thickened in the brownish epithecial gel; asci cylindric, 14–16 μ in diameter, 8-spored; ascospores imbricately monostichous, fusiform, thin-walled, with 5 transverse septa, 22–30 x 11–13 μ.

This species previously reported only from the type locality has yet been found only at low elevations on the Pacific slope.

San José: Turrúcares, 540–600 m., *Dodge & Thomas 8047.*

Guanacaste: Liberia, 100 m., *Dodge, Alfaro & Thomas 6586, Dodge & Thomas 8028,* Tilarán, 500–690 m., *Dodge & Thomas 8046.*

Var. **pichneoides** Dodge, var. nov.

Type: Costa Rica, Guanacaste, H. Santamaría, *Dodge & Thomas 8029.*

Thallus isidiosus, marginibus microphyllinis aut isidiosis. Apothecium margine tenuiore, laevi, thecium 130–150 μ altitudine.

Thallus isidiose, margins varying from dentate to short isidiose or slightly microphylline. Apothecia with thinner, smooth margins, thecium 130–150 μ tall.

Only the type has been found fertile and here there are very few apothecia. The other collections cited probably belong here, but it is always difficult to determine sterile isidiose specimens in this genus.

Alajuela: R. Ciruela, 920–980 m., *Dodge & J. Valerio 4894.*

Guanacaste: H. Santamaría, 640–680 m., *Dodge & Thomas 8029.*

Besides the species cited above, a single small fragment was found which seems to belong in *Leptogiopsis,* but more material is necessary for a satisfactory disposition.

PANNARIACEAE

Thallus squamose or foliose, not gelified; hypothallus and rhizinae usually highly developed, heteromerous, cortex of erect, irregular or periclinal hyphae, usually more or less pseudoparenchymatic; medulla well developed, with *Nostoc, Scytonema,* or *Dactylococcus;* lower cortex of thick-walled periclinal hyphae often thin or wholly absent. Apothecia marginal or scattered over the upper surface, biatorine or lecanorine; paraphyses unbranched; asci 8-spored; spores hyaline, unicellular, rarely 2–4-celled; spermatia short, straight.

This family seems to be of southern origin with some genera confined to the southern hemisphere, while a few species come northward until they are circumpolar. In general, the northern species are much smaller and more depauperate than the southern species.

In many ways the family seems very homogeneous, so that

genus distinctions are often rather arbitrary. Hue, in 1912, reduced the whole family to a single genus, but his sections and subsections correspond more or less closely to the genera of earlier workers. Zahlbruckner has recognized twelve genera, although the generic delimitation is not altogether clear. Following this treatment I have tentatively recognized seven genera from Tropical America. *Psoroma*, with *Dactylococcus* algae, is largely confined to the southern hemisphere, and by many authors has been placed in the Lecanoraceae. *Lepidocollema*, with a thin upper cortex and almost homoeomerous, is very close to the Collemaceae and is known from a single collection in Brasil. The other five genera are much better known and widespread in the American tropics.

The morphology of the thallus is not altogether clear and the nomenclature of the parts is rather confusing. In the ideal case, the uppermost layer of the thallus, here called "tomentum," is a mass of loosely woven hyphae formed by proliferation of deeper layers. In *Erioderma* it is soft and spongy, like a loose felt, while in *Malmella* and in some of the isidiose members of *Pannaria* it has the appearance of a fine blotting paper, or in *Coccocarpia* the hyphae are more conspicuously parallel and conglutinate, suggesting a frayed cotton yarn. In some species of each genus the tomentum is partly evanescent, or occasionally it is conglutinated into spines or warts. Below the tomentum is an upper cortex of pseudoparenchyma, usually formed by the partial disintegration of a palisade of large thick-walled hyphae which occasionally penetrate between the algal filaments. In *Coccocarpia* the pseudoparenchyma is thin and scarcely distinguishable from the tomentum or even absent. The algal zone varies from a dense palisade of filaments of *Scytonema* and hyphae in some species, to ellipsoidal colonies of *Nostoc* surrounded by hyphae. The medulla in most genera consists of loosely tangled hyphae, occasionally not even well differentiated from the algal layer, while in *Coccocarpia* it is formed of septate periclinal hyphae, scarcely to be distinguished from the lower cortex except in color and the size of the intercellular spaces. The lower cortex may be completely absent or consist of one or more layers of thick-walled periclinal hyphae which give rise to

tufts of rhizinae. The so-called hypothallus in most species is a thick dense mat of rhizinae, which may be absent in *Erioderma*, or occasionally only slightly developed in certain species of the other genera.

The morphology of the apothecium is equally confusing. In *Pannaria* and *Malmella* an amphithecium is present, usually with a pseudoparenchymatous cortex, and a thin algal layer which may be separated from the parathecium by a thin medulla. The parathecium is pseudoparenchymatous, formed from thick-walled periclinal hyphae in *Lepidocollema, Parmeliella, Coccocarpia, Erioderma*, and the smooth species of *Pannaria*, while in the isidiose species of *Pannaria* and in *Malmella* the parathecium is filamentous, in the former of large thin-walled cells, in the latter of slender hyphae. The hypothecium is differentiated somewhat in the species of *Pannaria* but practically undifferentiated in the other genera. Instead of the above interpretation those with a filamentous parathecium might be conceived as lacking a parathecium and having a somewhat highly developed hypothecium, or perhaps the so-called parathecium is really only a compact medulla of the amphithecium. Further study of the morphology of the developmental stages, also more representatives of some of the genera, are necessary before the correctness of any interpretation can be assured.

KEY TO THE TROPICAL AMERICAN GENERA OF PANNARIACEAE

Thallus with Chlorophyceae; apothecia lecanorine, rhizinae little developed or absent; Perú .... *Psoroma cinchonarum*

Thallus with Myxophyceae; rhizinae usually well developed.

  Upper cortex thin, pseudoparenchymatous, algal layer occupying most of the thallus; apothecia biatorine; Brasil .... *Lepidocollema carassense*

  Upper cortex well developed, pseudoparenchymatous.

    Upper cortex of two or more rows of cells; hyphae perpendicular to the surface, medulla loosely woven.

      Apothecia lecanorine.

        Tomentum absent or very early evanescent, algae definitely *Nostoc*, colonies usually separate; parathecium usually pseudoparenchymatous .... *Pannaria*

        Tomentum thin but persistent, algae *Nostoc*? or perhaps *Scytonema;* parathecium of slender hyphae .... *Malmella*

      Apothecia biatorine, pseudoparenchymatous from periclinal hyphae.

        Tomentum absent, algae *Nostoc;* rhizinae well developed.... *Parmeliella*

        Tomentum present and highly developed, algae *Scytonema* or *Nostoc;* lower cortex little developed; apothecia large, marginal .... *Erioderma*

Upper cortex of septate periclinal hyphae which may simulate pseudoparenchyma, tomentum usually absent; apothecia biatorine, medulla of periclinal conglutinate hyphae appearing pseudoparenchymatous, algae *Scytonema*. . . . . *Coccocarpia*

PANNARIA Del. ap. Bory

PANNARIA Del. ap. Bory, Dict. Class. Hist. Nat. **13**: 20. 1828.

Type species: *Pannaria rubiginosa* (Thunberg ap. Ach.) Del. ap. Bory.

Thallus granular, squamose to foliose with a well-developed bluish black or black hypothallus, rarely with dark, more or less tangled rhizinae below, heteromerous, upper surface corticate with large-celled pseudoparenchyma formed from a palisade of hyphae; algae *Nostoc*, medulla single or double, in the former case arachnoid, in the latter the upper portion of more or less parallel, thin-walled hyphae, loosely woven, and below of densely tangled hyphae, without lower cortex. Apothecia at first sunk in the thallus, finally sessile or peltate, superficial; amphithecium pseudoparenchymatous with a few algae in the center; hypothecium hyaline; asci clavate, 8-spored; ascospores hyaline, elongate, ellipsoidal to almost fusiform with a somewhat thickened and finely verrucose wall. Spermagonia in hemispherical warts, spermatiophores septate with short, broad cells; spermatia straight or very slightly curved, elongate, cylindrical.

This genus seems one of the most variable and widespread of the family, occurring from the Arctic to the Antarctic, in Costa Rica occurring from sea level to 1700 m.

In tropical America the genus separates easily into two sections, the isidiose species with a filamentous parathecium, and the smooth species with a pseudoparenchymatous parathecium.

KEY TO THE TROPICAL AMERICAN SPECIES OF PANNARIA

Hypothallus not well developed, pale with pale rhizinae below.

Thecium 80–100 μ or less tall; parathecium filamentous; hypothecium not differentiated; spores 11–12 x 4–5 μ, more or less constricted at the middle and appearing 2-celled; S. Africa. . . . . *P. rubiginosa*

Thecium 100–120 μ or more tall; parathecium of septate hyphae; hypothecium pseudoparenchymatous; spores 13–16 x 7–9 μ; Rio Grande do Sul, Brasil [*P. rubiginosa* Malme non aliorum]. . . . . *P. Malmei*

Hypothallus developed, sometimes sparingly.

Hypothallus pale, thallus squamulose, pale olivaceous to rusty yellow, margin cut-crenate, irregularly lobulate; spores 8–9 x 2.5–3 μ; Mexico. . . . . *P. applanata*

Hypothallus black.
Thallus isidioid.
Margins and surface with cylindrical, coralloid branched isidia; spores 14–19 x 7–8.5 μ; Antilles and Brasil .... *P. stylophora*
Margins isidio-lacinulate; spores 8–10 x 5–6 μ, with thick epispore; Minas Geraes, Brasil .... *P. isidioidea*
Margins with verruciform isidia, lobes under 1 mm. broad; apothecia 1–1.5 mm. in diam.; spores 12–14 x 8–10 μ, wall thin and smooth. .... *P. Moseni*
Thallus without isidia or soredia.
Thallus livid fuscescent, radiately broad-lobed; spores 14 x 6 μ; hypothallus less developed, center glebulose-lobed; São Paulo, Brasil. .... *P. imbricatula*
Thallus pallid or ashy or pale glaucous, lobes subcuneate, up to 2 mm. broad; spores 12–15(–18) x 8–9(–10) μ; parathecium and hypothecium pseudoparenchymatous .... *P. Vainii*
Thallus coeruleo-ashy, lobes cuneate obovate; epithecium black aeruginous; spores 12–20 x 7–8 μ, surface subplicate; São Paulo, Brasil.. .... *P. caeruleo-nigricans*
Thallus livid glaucescent or lurid pallid, laciniae very distinctly radiate-stellate, even subimbricate .... *P. radiata*
Thallus pale fuscescent, lobes 2–2.5 mm. broad and about 6 mm. long; epithecium rufous; spores 12–19 x 8–10 μ; parathecium pseudoparenchymatous; hypothecium of conglutinate vertical hyphae; Brasil .... *P. brasiliensis*

PANNARIA ISIDIOIDEA Vainio, Ann. Acad. Sci. Fenn. **A6**[7]: 102. 1915.

Pannaria Mariana var. *isidioidea* Vainio, Étude Lich. Brésil **1**: 206. 1890, excl. syn.

Type: Brasil, Minas Geraes, Sitio, 1000 m., *Vainio 669, 983* (sterile). The following description is based on fertile specimens from Costa Rica.

Hypothallus of dark green rhizinae extending only slightly beyond the thallus; thallus dark olive buff, margins lighter, surface very minutely tomentose, pinnatifid dissected, lobes somewhat cuneate, about 1 mm. wide, ultimate lobules rounded, 0.25–0.5 mm. broad, toward center becoming microphylline and subisidiose but isidia somewhat flattened, rarely cylindric, 150–160 μ thick, upper 40 μ of pseudoparenchymatous cortex, algal layer of *Nostoc* about 40 μ thick, and medulla 40 μ thick, of loosely woven hyphae with occasional small chains of *Nostoc;* rhizinae thick-walled, black, 6–8 μ in diameter. Apothecia crowded, peltate, constricted at the base, about 1 mm. in diameter, margin prominent, crenulate, almost lobulate, disc

chestnut; amphithecium 200 μ thick, of the same texture as the cortex and algal layer of the thallus; parathecium 60 μ thick, filamentous, of large thin-walled periclinal hyphae, ending above in a false pseudoparenchyma; hypothecium about 20 μ thick, of similar structure but more deeply staining; thecium 80–100 μ tall; paraphyses slender, filiform, somewhat clavate above in the brownish epithecial gel; asci clavate, 12 μ in diameter; ascospores ellipsoidal with a thick epispore, 8–10 x 5–6 μ (perhaps still immature).

This species is somewhat variable in appearance and perhaps should be separated into varieties and forms but I have not seen sufficient material to do so properly. Sterile material has been referred here solely on the structure of the thallus. *Dodge & Thomas 6558* from Tilarán has a white reticulate cortex.

Cartago: R. Birrís, 1220–1340 m., *Dodge & Thomas 4559.*

Heredia: C. Central de Zurquí, 1600–1700 m., *Dodge, J. Valerio & Thomas 6048.*

Alajuela: Piedades de S. Ramón, 900 m., *Brenes 375.*

Guanacaste: H. Santamaría, 640–680 m., *Dodge & Thomas 6823, 6911, 6988;* Tilarán, 500–690 m., *Dodge & Thomas 8059, 6558.*

Var. **pulvinata** Dodge, var. nov.

Type: Costa Rica, Alajuela, C. de Pata de Gallo a S. Rafael de S. Ramón, 1200–1250 m., *Brenes.*

Thallus ut in *P. isidioidea* sed isidiosissimus, marginibus adscendentibus, cinerascentibus; isidia coralloidea, elongata, pulvinum formantia.

Thallus as in *P. isidioidea* but densely isidiose with ascending, cinerascent margins; the isidia coralloid, repeatedly branched, crowded, forming a cushion up to 2 cm. in diameter and 3–4 mm. thick.

This variety might easily be mistaken for a sterile pulvinate *Stereocaulon* or a *Siphula,* were it not for the occasional lobe at the margin which shows its relationship.

Alajuela: C. de Pata de Gallo a S. Rafael de S. Ramón, 1200–1250 m., *Brenes.*

PANNARIA **Moseni** Dodge, sp. nov.

Pannaria rubiginosa Malme, Ark. f. Bot. **20**^{3}: 7–8. 1924, pro parte.

Type: Brasil, São Paulo, Sororocaba near Santos, *Mosen 3284.*

Thallus albidus, subpinnatifidus, lobis 3–5 mm. longitudine, 0.8 mm. latitudine, apicibus rotundatis, marginibus loborum

verrucosis, vel etiam in centro thalli isidiosus, ad 140 μ crassitudine, cortex superior 30–35 μ crassitudine, pseudoparenchymaticus ex hyphis perpendicularibus formatus, zona nostocacea coloniis subsphericis 35 μ diametro metientibus, medulla ad 60 μ crassitudine hyphis laxe implexis, rhizinae brunneo-nigricantes, hyphis nigris pachydermaticis 3–4 μ diametro, conglutinatis. Apothecia 1–1.5 mm. diametro, marginibus tenuibus, crenato-lobatis et subisidiosis; amphithecium inferne 120 μ crassitudine superne ad 60 μ attenuatum, cortice 40 μ crassitudine, pseudoparenchymatico; parathecium bene evolutum, inferne 40 μ superne ad 60 μ crassitudine, hyphis ad 4 μ diametro leptodermaticis contextum; hypothecium 25 μ crassitudine, hyphis periclinalibus dense compactum; thecium ad 100 μ altitudine; paraphyses filiformes 1–2 μ diametro apicibus clavatis; asci clavati, 25 μ diametro; ascosporae octonae, distichae, 12–14 x 8–10 μ, episporio tenuiusculo.

Thallus pearl gray, subpinnatifid, lobes 3–5 x 0.8 mm., with rounded tips, margins of lobes verrucose or even occasionally cylindric, isidiose toward the center, about 140 μ thick, upper cortex 30–35 μ, pseudoparenchymatous from the breaking up of a palisade layer, algal zone of subspherical colonies of *Nostoc* about 35 μ in diameter, medulla about 60 μ thick, of loosely woven hyphae; rhizinae of brownish black thick-walled conglutinate hyphae 3–4 μ in diameter. Apothecia 1–1.5 mm. in diameter, margins thin, crenate-lobulate or even somewhat isidiose; amphithecium about 120 μ thick below, thinning to about 60 μ above with a cortex about 40 μ thick of pseudoparenchyma; parathecium well developed, about 40 μ below, spreading to 60 μ above, of interwoven thin-walled hyphae about 4 μ in diameter; hypothecium about 25 μ thick of dense periclinal hyphae, staining very deeply; thecium about 100 μ tall; paraphyses filiform, 1–2 μ in diameter, with clavate tips; asci clavate, 25 μ in diameter, 8-spored; ascospores distichous, 12–14 x 8–10 μ, with a somewhat thinner epispore.

It is with some hesitation that I have described this species as new. The thallus is very suggestive of the sterile *P. stylophora*, although it has a somewhat different color and lobing and rather larger dimensions of the parts. It does not seem to be closely

related to *P. rubiginosa*, originally described from Thunberg's South African collections, and is certainly not closely related to the material referred to that species in the North Temperate zone. So far I have only seen this species from the Atlantic Coastal Plain of Costa Rica.

Limón: Hamburg, *Standley & J. Valerio 48702, 48717;* R. Siquirres, 70–200 m., *Dodge, Catt & Thomas 8037.*

PANNARIA STYLOPHORA Vainio, Ann. Acad. Sci. Fenn. **A6**[7]: 102. 1915.

Type: Antilles, Guadeloupe, Sofaga, *P. Duss 1387* (sterile).

Hypothallus black, extending slightly beyond the thallus; thallus with pale olive gray margins and olive gray center, lobes long, slender, oblong, 0.5–0.8 mm. wide, and primary lobes about 15 mm. long, irregularly more or less pinnatifid, smooth above around the margin, the center with scattered to crowded cylindrical isidia which are rarely dichotomously branched, and concolorous, about 125 μ thick, upper cortex 20–25 μ, pseudoparenchymatous from the development of a palisade layer; algal layer about 40 μ thick, consisting of ellipsoidal colonies of *Nostoc* about 30 x 40 μ; medulla about 60 μ thick, loosely woven; lower cortex absent; rhizinae of black thick-walled hyphae about 3–4 μ in diameter.

Limón: R. Siquirres, 70–200 m., *Dodge, Catt & Thomas 8036.*

PANNARIA **Vainii** Dodge, sp. nov.

Pannaria rubiginosa Vainio, Étude Lich. Brésil **1**: 204–205. 1890; Malme, Ark. f. Bot. **20**[3]: 7–8. 1924, quoad spec. *Duseníanum.*

Type: Brasil, Minas Geraes, Sitio, 1000 m., *Vainio 606.*

Hypothallus black, extending 1–2 mm. beyond thallus; thallus between olive buff and smoke gray, irregularly and repeatedly laciniate, lobes 1–2 mm. broad, ultimate lobes short, broader ones up to 4 mm. long, smooth above, not isidiose, about 160–170 μ thick, upper cortex 20–30 μ thick of 2–3 layers of large isodiametric cells; algal layer of spherical to ellipsoidal colonies of *Nostoc* about 60–65 μ in diameter, algae rather large and somewhat angular by mutual pressure, medulla about 80 μ thick of large, thin-walled hyphae, loosely interwoven; rhizinae of black, thick-walled, conglutinate hyphae. Apothecia peltate, 0.8–2

mm. in diameter, margin thick, crenulate, disc rufous; amphithecium 130–440 μ thick, with cortex 20–30 μ thick; parathecium well developed, about 60 μ thick of periclinal large, thin-walled, hyphae simulating pseudoparenchyma; hypothecium about 20 μ thick, of similar structure but of more slender less frequently septate hyphae; thecium 90–100 μ tall; paraphyses 1.5–2.5 μ in diameter, filiform, slightly clavate at the tips in a yellowish brown epithecial gel; asci 14–16 μ in diameter, 8-spored; ascospores distichous, broadly ellipsoidal, 12–18 x 8–10 μ, with thick epispore.

This species is another of the group which in various herbaria is often more or less indiscriminately determined as *P. rubiginosa*, *P. Mariana*, or even *P. nigrocincta*, usually without much critical attention to microscopic details.

Guanacaste: near Tilarán, both Atlantic and Pacific slopes, 500–690 m., *Standley & J. Valerio 44310*, *Dodge & Thomas 6564*, *6565*.

PANNARIA **radiata** (Vainio) Dodge, comb. nov.

Pannaria Mariana f. *radiata* Vainio, Ann. Acad. Sci. Fenn. **A6**[7]: 101–102. 1915, excl. syn.

Type: Antilles, Guadeloupe, *P. Duss.*

Hypothallus brownish black, extending about 1.5 mm. beyond the margin of the thallus, thick; thallus mineral gray with ends of lobes pale smoke gray, dichotomously (rarely trichotomously) divided, laciniae 1 cm. or more long, about 1 mm. broad, tips rounded, reflexed, wholly discrete in outer centimeter, thallus about 90 μ thick, upper cortex of large thin-walled pseudoparenchyma 20–30 μ thick, algal zone of *Nostoc* colonies ellipsoidal, about 40 μ in long diameter, medulla about 20 μ thick of loosely woven hyphae; rhizinae of conglutinate black thick-walled hyphae very closely woven at the lower side of the medulla and performing the function of a lower cortex. Apothecia mostly about 1 mm. in diameter, occasionally up to 2 mm., peltate, margin crenate, of medium prominence, disc rufous; amphithecium 160 μ thick, cortex about 60 μ thick, pseudoparenchymatous, *Nostoc* colonies smaller than in the thallus, separated by strands of pseudoparenchyma; parathecium pseudoparenchymatous, 60–80 μ thick, filamentous, of large very thick-walled hyphae appearing pseudoparenchymatous; hypothecium 15–20 μ thick,

of periclinal, thin-walled, slender hyphae; thecium 120–130 μ tall; paraphyses slender, filiform, septate, without clavate tips; asci 10–12 μ thick, 8-spored; ascospores irregularly distichous, ellipsoidal, 15–16 x 7–8 μ, with a very thick epispore.

This species shows little relationship to *P. Mariana* Fr. of the Old World, a species to which it has been referred. It seems closest to *P. Vainii* but differs in microscopic details and habit.

Limón: Hamburg, *Standley & J. Valerio 48763;* R. Siquirres, 70–200 m., *Dodge, Catt & Thomas 5596.*

MALMELLA Dodge

Malmella Dodge, gen. nov.

Type species: *Erioderma physcioides* Vainio.

Thallus squamosus aut microfoliosus, rhizinis nigris bene evolutus, tomentum superficiei superioris parce evolutum tenue, hyphis implexis sed non conglutinatis ut in *Coccocarpia;* cortex superior pseudoparenchymaticus, algae nostocaceae; medulla hyphis laxe implexis, cortex inferior tenuis hyphis nigris conglutinatis aut nullus. Apothecia lecanorina, sessilia, sparsa; amphithecium adest; parathecium non pseudoparenchymaticum; paraphyses filiformes; asci clavati; ascosporae octonae, ellipsoideae, episporio crasso.

Thallus squamose or small foliose, with a well-developed hypothallus of black rhizinae; tomentum of the upper surface less well developed than in *Erioderma*, of slender hyphae loosely woven, not conglutinate as in *Coccocarpia;* upper cortex pseudoparenchymatous, algae *Nostoc* ?, medulla of loosely tangled hyphae, lower cortex of black hyphae as in *Coccocarpia* or wholly absent. Apothecia lecanorine, sessile, scattered over the upper surface, not marginal as in *Erioderma;* amphithecium present; parathecium of slender hyphae, not pseudoparenchymatous; paraphyses filiform; asci clavate, 8-spored; ascospores ellipsoidal, with a thick epispore.

This genus seems intermediate between *Pannaria*, *Erioderma*, and *Coccocarpia*, and collections have been previously referred to each of these genera. In structure of the thallus it seems intermediate between *Pannaria* and *Erioderma*, while in superficial appearance it suggests the more laciniate species of *Coccocarpia*.

KEY TO THE TROPICAL AMERICAN SPECIES OF MALMELLA

Thallus becoming densely isidiose.
  Thallus olivaceous with isidia becoming pruinose and subsorediate, then appearing grayish.......... *M. Randii*
  Thallus white, more laciniate.......... *M. albida*
Thallus not isidiose, medulla not well differentiated from algal zone.
  Thallus white, 120 μ thick, thecium 140–160 μ tall.......... *M. Santamariae*
  Thallus olive buff or darker.
    Thallus olive buff, 120 μ thick, thecium 100–120 μ tall.......... *M. physcioides*
    Thallus dark olive with white pruina about margins, 200 μ thick, thecium 80–90 μ tall.......... *M. caesiocinerea*

MALMELLA **Randii** Dodge, n. sp.

Type: Maine, Mt. Desert Island, *E. L. Rand.*

Hypothallus rhizinis viridi-nigricantibus; thallus olivaceus, lobis subdichotomis aut irregularibus, 1.0–1.3 mm. latis, marginibus crispatis elevatisque, verrucosis et etiam isidioideis, glaber in lobis marginalibus, centro isidiosissimus, apicibus isidiorum pruinosis et subsorediosis; thallus 140–160 μ crassitudine, tomentum 12 μ crassitudine hyphis laxe implexis, tenuibus, subdilabentibus; zona nostocacea [vel scytonematica] 100 μ crassitudine, filamentis dense convolutis, in coloniis ellipsoideis, cellulis sphericis vel angularibus; medulla hyphis laxe implexis 2–3 μ diametro, aut plus minusve hyphis subparallelis ut in *Coccocarpia pellita,* frequenter ad margines; cortex inferior hyphis conglutinatis nigris tenuis.

Hypothallus of well-developed greenish black rhizinae extending about 0.5 mm. beyond the thallus; thallus ecru olive to buffy olive, main lobes subdichotomous or wholly irregular, 1.0–1.3 mm. broad, margin crisped and elevated, becoming verrucose and finally isidioid, surface appearing like surface of blotting paper under microscope, smooth on marginal lobes, becoming densely isidiose toward the center, the tips of the isidia soon becoming pruinose and subsorediate, giving a puritan gray appearance to the plant; thallus about 140–160 μ thick, the tomentum 12 μ thick of loosely appressed, somewhat tangled, slender hyphae which more or less disintegrate; the upper cortex 20 μ thick, of about 2 layers of cells from the palisade; algal zone about 100 μ thick, of closely coiled filaments, forming ellipsoidal colonies, cells spherical to angular from mutual pressure, *Nostoc* or perhaps *Scytonema;* medulla of loosely woven hyphae 2–3 μ

in diameter, in places more or less parallel as in *Coccocarpia pellita*, especially at the margin of the thallus with about 1 row of agglutinated black thick-walled hyphae functioning as a lower cortex, giving off rhizinae either as single hyphae or as small fascicles of hyphae; sterile.

This species has not been seen fertile and its systematic position is uncertain. It has somewhat the appearance of an isidiose *Malmella physcioides* but differs from the latter in a less well-developed tomentum, a thinner upper cortex, and a thicker algal zone. It differs much more from *Coccocarpia cronia* in the loosely tangled tomentum layer which is present in *Coccocarpia* but closely appressed and formed of longitudinal hyphae, in the loosely tangled medulla (in *Coccocarpia* almost pseudoparenchymatous of periclinal hyphae), and the much less developed lower cortex.

MALMELLA **albida** Dodge, sp. nov.

Type: Costa Rica, Limón, R. Siquirres, 70–200 m., *Dodge, Catt & Thomas 8060.*

Hypothallus crassus, niger, bene evolutus; thallus albidus, cinerascens, laciniatus, di- vel trichotomus aut irregularis, laciniis linearibus, 0.2–0.5 mm. latis, et superficiei marginibusque dense isidiosis, coralloideis, inferne niger, rhizinis nigricantibus; thallus 80–100 μ crassitudine, cortex superior hyphis periclinalibus 5 μ et cellulis pseudoparenchymatibus 20 μ metiens, zona nostocacea (scytonematica?) 60 μ crassitudine, filamentis contortis, cellulis sphericis, 4–5 μ diametro; medulla 40–45 μ crassitudine, hyphis laxis implexis; cortex inferior 8–12 μ crassitudine, hyphis nigris pachydermatibus conglutinatis compactus. Sterilis.

Hypothallus thick, black, well developed; thallus chalk-white, becoming ashy from isidia, laciniate, di- or trichotomous or wholly irregular, laciniae linear, 0.2–0.5 mm. broad, upper surface and margins densely isidiose, coralloid, below black with black rhizinae; thallus 80–100 μ thick, upper cortex about 25 μ thick, the outer 5 μ of periclinal hyphae, below which are about two layers of pseudoparenchymatous cells; the algal layer of *Nostoc* (*Scytonema* ?) about 60 μ thick, of contorted filaments of spherical cells 4–5 μ in diameter; medulla 40–45 μ thick, of loosely tangled hyphae; lower cortex 8–12 μ thick, of thick-walled,

black, conglutinate hyphae; sterile. Known only from a single small collection in Costa Rica.

Limón: R. Siquirres, 70–200 m., *Dodge, Catt & Thomas 8060.*

MALMELLA **Santamariae** Dodge, n. sp.

Type: Costa Rica, Guanacaste, H. Santamaría, 640–680 m., *Dodge & Thomas 8049.*

Hypothallus nullus sed rhizinae coeruleo-nigricantes, dense implexi, ei simulantes; thallus albidus, minute tomentosus, palmatim lobatus, lobis oblongis, 0.5–1 mm. latitudine, 120 µ crassitudine, cortice filamentosa, 15–20 µ crassitudine hyphis pachydermaticis periclinalibus; strato nostocaceo 40 µ crassitudine in medulla gradatim transeunte, rhizinis nigris pachydermaticis 4–5 µ diametro metientibus. Apothecia 0.5–0.75 mm. diametro marginibus crassisimis crenulatis inflexis, disco nigro; amphithecium inferne 140 µ crassitudine superne ad 100 µ attenuatum, cortice 40 µ crassitudine pseudoparenchymatico; parathecium 20–30 µ crassitudine, hyphis tenuibus periclinalibus dense implexis; thecium 140–160 µ altitudine; paraphyses tenues, filiformes, apicibus in gelatina dilabentibus; asci clavati, 12 µ diametro; ascosporae distichae, octonae, 10–11 x 7–8 µ, ellipsoideae, episporiis crassis.

Hypothallus of densely tangled bluish black rhizinae; thallus white, minutely tomentose, palmately lobed, lobes oblong, 0.5–1.0 mm. broad, 120 µ thick; cortex filamentous, 15–20 µ thick, of thick-walled hyphae, algal layer of *Nostoc* gradually merging into the medulla; rhizinae thick-walled, black, 4–5 µ in diameter. Apothecia 0.5–0.75 mm. in diameter, with very thick inrolled margins and blackening disc; amphithecium 140 µ thick below, thinning to 100 µ at the margin, cortex 40 µ thick, pseudoparenchymatous; parathecium 20–30 µ thick, of densely appressed periclinal hyphae not clearly differentiated from the hypothecium; thecium 140–160 µ tall; paraphyses very slender, filiform, degenerating into the dark brown epithecial gel; asci clavate, 12 µ in diameter, 8-spored; ascospores distichous, ellipsoidal, with thick epispore, 10–11 x 7–8 µ.

While eventually this species may be found to have a much wider distribution, it seems fitting that the excellent H. Santamaría, with one of the richest lichen floras known to me, should be

commemorated in botanical literature. The hacienda in turn preserves the name of the national hero of Costa Rica not far from the scene of his famous exploits.

Guanacaste: H. Santamaría, 640–680 m., *Dodge & Thomas 8049.*

MALMELLA **physcioides** (Vainio) Dodge, n. comb.

Erioderma physcioides Vainio, Jour. Bot. Brit. & For. **34:** 70. 1896.

Type: West Indies, St. Vincent, Boxwood, *W. R. Elliott 252.*

Hypothallus sparingly developed, strigose-pannose, greenish black; thallus deep olive buff, radiately subpinnatifid, ultimate lobes 1–1.5 mm. broad, short and convex, surface toward the margin slightly spongy, very minutely verrucose, about 120 μ thick, upper cortex about 40 μ thick, of large thin-walled pseudoparenchyma, the rest of loosely woven hyphae with very small, separate colonies of *Nostoc,* the lower 10 μ with more densely woven, more or less parallel hyphae. Apothecia circular to quite irregular by mutual pressure, crowded, about 1 mm. in diameter, margin concolorous with the thallus, crenulate, disc chestnut; amphithecium about 200 μ thick, the outer 60 μ of tomentum consisting of slender, thin-walled hyphae more or less perpendicular to the surface and somewhat tangled. Within this is the true cortex about 30 μ thick of large-celled pseudoparenchyma, thinning out to a single layer above, and the algal layer of slender periclinal thin-walled hyphae and colonies of *Nostoc* about 100 μ thick below and about 80 μ above; parathecium about 40 μ thick, of densely woven periclinal hyphae, staining very lightly and reaching the margin above; hypothecium deeply staining, 15–20 μ thick, of densely woven hyphae; thecium 100–120 μ tall; paraphyses filiform, 2 μ in diameter, frequently septate, disintegrating into the brownish epithecial gel; asci clavate, 6–8 μ in diameter, 8-spored; ascospores broadly ellipsoidal, 10–12 x 6–8 μ, with a gelified wall, minutely roughened within.

Previously reported only from the type locality. I have previously distributed duplicate material of this species under the name *P. imbricatula* Müll. Arg., which was originally briefly described from southern Brasil. Only a careful study of both types can settle its identity and relationships.

Alajuela: Fraijanes, 1500–1700 m., *Standley & J. Valerio 47651;* S. Isidro de Alajuela, 980–1300 m., *Dodge, J. Valerio & Thomas 4883.*

Guanacaste: H. Santamaría, 640–780 m., *Dodge & Thomas 8034, 8035.*

Malmella **caesiocinerea** (Vainio) Dodge, n. comb.

Pannaria rubiginosa f. *cinerascens* Vainio, Jour. Bot. Brit. & For. **34:** 70 [10]. 1896, non Nyl.

Pannaria rubiginosa f. *caesiocinerea* Vainio, Acta Soc. Sci. Fenn. **A6**[7]: 102–103. 1915.

Type: not stated although several specimens mentioned. *P. rubiginosa* f. *cinerascens* Vain. based on Antilles, St. Vincent, Mt. St. Andrews, 320 m., *Elliott 15.* The following description is based on Costa Rican material.

Rhizinae bluish black, highly developed and tangled; thallus buffy brown in the center, lobes dark olive with a white pruina about the margins, tomentose, lobes rounded, 1–4 mm. broad, sinuate, incised, the lobules oblong, about 0.5 mm. broad, convex, margins thick, inflexed below, 200 μ thick, the upper cortex a palisade of thick-walled hyphae about 20 μ thick, homoeomerous, with coiled filaments of *Nostoc* distributed throughout a very loosely tangled layer of hyphae, fraying out below without lower cortex. Apothecia up to about 0.5 mm. in diameter, margin very thick and inrolled, white, crenulate, disc black; amphithecium thick, continuous with the thallus, about 140 μ thick, with cortex about 60 μ thick below and with algae much more abundant and closely tangled than in the thallus; parathecium thin, filamentous, 20 μ thick, not differentiated from the hypothecium; thecium 80–90 μ tall; paraphyses filiform, septate, ending in the hypothecial gel which is deep brown and deeply staining; asci clavate, about 20 μ in diameter, 8-spored; ascospores distichous, ellipsoidal, 11–12 x 6–7 μ, with a gelified epispore about 2 μ thick, sometimes appearing 2-celled or even 4-celled with 2 transverse septa and 1 longitudinal septum in the middle, probably due to oil globules or other highly refractive substances, as other spores in the same ascus seem to be definitely unicellular.

This species suggests a close relationship with *Lepidocollema* but the cortex is much better developed and the apothecium is lecanorine.

Guanacaste: H. Santamaría, 640–680 m., *Dodge & Thomas 8033.*

PARMELIELLA Müll. Arg.

Parmeliella Müll. Arg., Mem. Soc. Phys. Hist. Nat. Genève **16:** 376. 1862.

Type species: *P. triptophylla* (Ach.) Müll. Arg. [*P. corallinoides* (Hoffm.) Zahlbr.].

Thallus squamose, becoming elongate and subfoliose at the margins with a well-developed dark hypothallus, algae *Nostoc;* upper cortex of thick-walled pseudoparenchyma; medulla loosely woven; lower cortex an appressed layer of rhizinae. Apothecia superficial; amphithecium absent; parathecium pseudoparenchymatous; asci 8-spored; spores hyaline, unicellular, elongate-ellipsoidal with thin walls; spermatia short, straight.

This genus seems world-wide in its distribution, perhaps predominantly of the southern hemisphere but widespread in the North Temperate zone and in the tropics, preferring the higher elevations. Only *P. pannosa* has yet been found in Costa Rica. The other species have been incompletely described but have characters which should make them recognizable if found.

KEY TO THE TROPICAL AMERICAN SPECIES OF PARMELIELLA

Hypothallus indistinct, thallus glauco-cinereous or pale, squamules confluent, crenate, granulate; spores small, 8–9 x 4–6 μ; Chile. . . . *P. microphylloides*

Hypothallus forming a black margin about the thallus.

- Hypothallus very thin, blue green; spores 15–19(–21) x 6.5–8 μ; surface smooth; thecium 100 μ thick; Chile. . . . . *P. nigrocincta*
- Hypothallus blue black, densely woven, cortex a single layer of cells; spores 11–17 x 5–8 μ; thecium 110 μ thick; Mexico. . . . . *P. miradorensis*
- Hypothallus brownish black, densely woven and thick, cortex several layers of pseudoparenchyma; spores 12–15(–18) x 6–8 μ; thecium 120–140 μ thick. . . . . *P. pannosa*
- Hypothallus very thick; apothecia 1–1.5 mm. in diam.; spores 16–25 x 8–10 μ; Bolivia. . . . . *P. nigrocincta* var. *Weddellii*

PARMELIELLA PANNOSA (Sw.) Müll. Arg., Flora 64: 86. 1881.

Lichen pannosus Sw., Nova Gen. Sp. Pl. Prodr. 146. 1788; Fl. Ind. Occ. 3: 1888. 1806.

Type: Jamaica, *O. Swartz.*

Hypothallus brownish black, extending 1–2 mm. beyond the thallus; thallus tawny olive to isabelline, irregularly somewhat pinnatifidly divided in the margin, the central portion of the thallus becoming appressed microphylline and even somewhat isidioid, margins of lobes somewhat lighter in color, otherwise smooth above; thallus about 100 μ thick, the upper cortex 40 μ thick, of large thick-walled spherical cells forming a pseudoparenchyma, algal zone thin, about 20 μ thick, of small somewhat

confluent colonies, medulla about 40 μ thick, of large thin-walled, loosely woven hyphae, the lower cortex 10–12 μ thick, of conglutinate, black, thick-walled hyphae. Apothecia abundant, about 1 mm. in diameter, round to irregular in shape, the margin lighter colored when young, appearing to be thalline but not so, darkening in age but always slightly lighter than the disc and not exceeding the epithecium in height, disc rufous; amphithecium absent; parathecium 100–120 μ thick, pseudoparenchymatous, of large thick-walled cells extending to the top of the thecium; hypothecium about 40 μ thick, of densely woven hyphae, deeply staining; thecium 120–140 μ thick; paraphyses branched above, 1.5–2 μ in diameter, with thin walls; asci clavate, about 15 μ in diameter, 8-spored; ascospores irregularly distichous, ellipsoidal, 12–15 x 6–8 μ, epispore thick.

This species seems to be the commonest one in tropical America, in our area confined largely to higher elevations than *Pannaria*, being most abundant above 650 m., but rarely found at lower elevations.

Without locality: *Ørsted 8*.

Limón: Waldeck, *Dodge 7403*.

Cartago: R. Pejivalle, 600–750 m., *Dodge & Thomas 4341, 8038;* Cartago, 1200–1500 m., *C. Wercklé* (Mus. Nac. 17218).

San José: Sta. María de Dota, 1500–1800 m., *Standley & J. Valerio 43394, 44057, 43444, 43446, 43472;* La Hondura, 1300–1700 m., *Standley 36458b.*

Heredia: Barba, El Gallito, *R. Torres 150;* C. Central de Zurquí, 1600–1700 m., *Dodge, J. Valerio & Thomas 8039.*

Alajuela: S. Ramón, La Palma, 1100 m., *Brenes 54;* Piedades, 900 m., *Brenes 380;* Alto Calera, 750–800 m., *Brenes 265.*

Guanacaste: H. Santamaría, 680–780 m., *Dodge & Thomas 6892;* H. Granadilla, 500–600 m., *Dodge & Thomas 6746.*

Var. **coralloidea** Dodge, var. nov.

Type: Costa Rica, Heredia, C. Zurquí, 1600–1700 m., *Dodge, J. Valerio & Thomas 8061.*

Thallus iteratim laciniatus sed non microphyllinus, isidiis coralloideis marginalibus rare sparsis, obscurior, 140 μ crassitudine, cortex superior 25–30 μ crassitudine, duobus seriebus cellularum, serie superiore fusca, inferiore hyalina; stratum nostocaceum ad 60 μ crassitudine, filamentis dense contextum; medulla hyphis magnis laxe implexa; cortex inferior ad 12 μ crassitudine, hyphis nigris, pachydermaticis, conglutinatis, compactus; sterilis.

Thallus repeatedly laciniate but not microphylline, isidia coralloid, mostly marginal, rarely scattered over the surface, darker, 140 μ thick, the upper cortex 25–30 μ thick, of two layers of thick-walled cells, the outer layer fuscous, the inner hyaline; the algal layer about 60 μ thick, of densely woven filaments of *Nostoc;* medulla of large loosely tangled hyphae; lower cortex about 12 μ thick of large black, thick-walled hyphae; sterile.

Heredia: C. Central de Zurquí, 1600–1700 m., *Dodge, J. Valerio & Thomas 8061.*

ERIODERMA Fée

Erioderma Fée, Essai Cryptog. Ecorc. Offic. 146. 1824.

Type species: *Erioderma polycarpum* Fée.

Thallus foliose, attached to the substrate by either marginal rhizinae or those from the under surface; tomentum highly developed, cortex pseudoparenchymatous, formed by a palisade layer, the algal zone of short chains of *Scytonema* with thin sheaths or *Nostoc;* medulla loosely woven of thin-walled hyphae; no lower cortex, the lower surface somewhat veined and in some species with a dense covering of rhizinae. Apothecia marginal or superficial, peltate, constricted at the base; amphithecium absent; parathecium well developed, of large thick-walled cells, pseudoparenchymatous, with a loosely woven medulla; asci 8-spored; spores hyaline, unicellular, ellipsoidal, occasionally fusiform or subspherical. Spermagonia marginal, small, blackish warts; spermatiophores septate; spermatia short, cylindric, straight.

KEY TO THE TROPICAL AMERICAN SPECIES OF ERIODERMA

Dense blackish fuscous tomentum below, suggesting hypothallus.
  Lobes narrow, deeply sinuate divided margins.................... *E. Wrightii*
  Lobes broader, margin with sub-granulate caesious soredia below, and white-villose.. *E. limbatum*
Nearly nude and veined, white below, although rhizinae bluish black or white, verruculose and villose above; Brasil.................... *E. verruculosum*
Sulphur yellow below with white veins and rhizoids, coarsely short-pilose above; apothecia up to 0.8 mm. in diam.; Jamaica.............. *E. microcarpa*
Bluish white with fleshy white veins and rhizoids, hairs tufted above, giving an irpiciform appearance when dry; apothecia 3–4 mm. in diam.; Brasil.. *E. pulchrum*
White below; thallus isidiose; apothecial margin isidiose, ashy virescent above; Brasil.. *E. Leylandi*

Erioderma Wrightii Tuck., Amer. Jour. Arts & Sci. II, **25:** 423. 1858.

Type: Cuba, top of Loma del Gato, *C. Wright.*

Hypothallus none, but dense brownish-black rhizinae clothe the under surface to within 3 mm. of the margin which is arachnoid-tomentose, white; thallus deep olive buff to citrine drab, sinuate-lobed, upper surface tomentose, margins with tufts of dark brown rhizinae, thallus about 120 μ thick exclusive of tomentum on upper surface and rhizinae below; cortex pseudoparenchymatous, 30–40 μ thick, of large cells, algal layer very thin, 10–15 μ thick, of densely coiled filaments of *Scytonema;* medulla very loosely woven, similar to the tomentum above; no lower cortex. Apothecia marginal with white densely pilose exciple and black disc; amphithecium absent; parathecium 200 μ thick, corticate with pseudoparenchyma about 25 μ thick below, a little less above, formed from a palisade of hyphae perpendicular to the surface, the cortex covered with tomentum as in the thallus, the rest of the parathecium of large, loosely woven hyphae similar to the medulla but somewhat more closely woven; hypothecium not well differentiated from the parathecium, rather more densely woven; thecium about 120 μ tall; paraphyses filiform, slender, branched above, ending in dense brown epithecial gel; asci clavate, 8-spored, 14–16 μ in diameter; ascospores distichous, 12–14 x 6–7 μ, ellipsoidal, with a thick epispore.

This very distinct species resembles the Peltigeraceae in habit much more than the Pannariaceae, but it has the typical unicellular spore with the thick epispore of the latter family. It seems rather rare in tropical America but it is quite abundant in the few localities where it has been found. In Costa Rica it occurs from 680 to 1100 m.

Alajuela: La Palma de S. Ramón, 1100 m., *Brenes 50.*
Guanacaste: H. Santamaría, 680–780 m., *Dodge & Thomas 6920, 6982.*

Erioderma **limbatum** (Nyl.) Dodge, n. comb.

Erioderma Wrightii var. *limbatum* Nyl., Flora **52:** 119. 1869.

Type: Brasil, Rio de Janeiro, Serra dos Orgãos, *Glaziou 2004.*

Thallus cinnamon buff to chamois, lobes rounded-sinuate, slightly excised, 5 mm. broad, margins crenate, thick, upper surface only slightly tomentose, lower surface with margins caesious-sorediate, white; rhizinae greenish black, very dense and thick; thallus about 300 μ thick, upper tomentum not highly

developed; cortex 25–30 μ thick, pseudoparenchymatous from the disintegration of a palisade; algal layer about 60 μ thick, of irregularly tangled filaments of irregular somewhat angular cells about 8 μ in diameter (*Scytonema* ?); medulla about 60 μ thick next the cortex, of rather densely tangled hyphae, gradually becoming looser to form another indefinite layer 120 μ thick, of very large and very loosely tangled hyphae 10–12 μ in diameter, with black hyphae of about the same size forming a more dense mat which serves as a lower cortex. Apothecia 3 mm. in diameter, stipitate, stipe 1–2 mm. tall, margin thin, erect or incurved, densely tomentose without, the hairs tangled, giving a granular appearance, disc chestnut, soon blackening; no amphithecium; parathecium highly developed, cortex a palisade of thick-walled infrequently septate hyphae proliferating to form the tomentum and medulla, 200 μ or more thick below, thinning out at the edge of the thecium so that only the cortex about 100 μ thick surrounds the upper portion of the thecium at the margin; hypothecium not differentiated; thecium about 90 μ tall; paraphyses slender, filiform, apex not enlarged; asci cylindrical, about 8 μ in diameter, 8-spored; ascospores monostichous, at least when found, thick-walled, hyaline, ellipsoidal, 10–12 x 5–6 μ.

This species, from its habit and color, might easily be mistaken for *Sticta Weigelii* or *S. rufa* except for a somewhat duller surface, but is distinguishable on the color and density of the rhizinae and the lack of cyphellae. Known from Costa Rica from a single collection with scant data by *Brenes* . . . *a*, probably from the region of S. Ramón in Alajuela Province.

COCCOCARPIA Pers. ap. Gaudich.

COCCOCARPIA Pers. ap. Gaudich. in Freycinet, Voy. Uranie, Bot. 206. 1826.

Type species: *Coccocarpia molybdaea* Pers. ap. Gaudich.

Thallus squamose to foliose, with dark or light-colored rhizinae, corticate on both surfaces, upper surface pseudoparenchymatous from thin-walled large hyphae parallel to the surface, without tomentum; algal layer of coiled chains of *Scytonema* in thin sheaths; medulla of thin-walled somewhat conglutinate hyphae not sharply differentiated from the lower cortex, of more or less

septate hyphae running parallel to the surface. Apothecia superficial, sessile or somewhat constricted below; amphithecium absent; parathecium corticate with large-celled pseudoparenchyma, within, of large septate periclinal hyphae, medulla lacking; hypothecium either light or dark; asci 8-spored; ascospores hyaline, unicellular, spherical to ellipsoidal-fusiform, thin-walled. Spermagonia in warts on the thallus, spermatiophores frequently septate; spermatia straight, elongate-cylindric.

This widespread tropical genus has two very widespread species or species groups and a number of rare and seemingly localized species scattered over the tropical regions.

KEY TO THE TROPICAL AMERICAN SPECIES OF COCCOCARPIA

Under side reticulate, black-fibrillose; lobes obtuse, ciliate, margin of apothecia crenulate, disc yellow.............................*C. portoricensis*
Under side densely black-tomentose, forming a hypothallus.
  Lobes bipinnately divided, linear, ciliate, aeruginous-green...........*C. subtilis*
  Lobes cuneate to flabelliform, bluish to lead color.
    Thallus isidiose or microphylline in the center.....................*C. cronia*
      Thallus not reddish ferruginous within.
        Isidia concolorous, laciniae cuneate, 1.5–10 mm. broad.
          Laciniae 5–10 mm. broad, isidia applanate to microphylline.... ....v. *prolificans*
          Laciniae 1.5–5 mm. broad, isidia terete; apothecia yellow or rufo-fuscous, exciple white-ciliate..................v. *isidiophylla*
        Isidia usually darker at the tips and blackening, laciniae narrower and sublinear.
          Laciniae 1–1.5 mm. broad; hypothallus little developed; apothecia fuscous, blackening, exciple white-ciliate; Brasil..v. *camporum*
          Laciniae 0.5–3.0 mm. broad, narrow granulose to lobulate in the center; apothecia black; hypothallus well developed....v. *granulosa*
      Thallus reddish ferruginous within; Cuba................v. *erythrocardia*
    Thallus not isidiose in center...................................*C. pellita*
      Laciniae cuneate or broad-spathulate.
        Hypothallus very highly developed; apothecia yellow to tawny when young...v. *pannosa*
        Hypothallus present but much less well developed.
          Apothecia black from the first, laciniae broad...........v. *parmelioides*
          Apothecia yellow, rufous, or fuscous.
            Thallus very thin, lobes small, approaching microphylline states of *C. cronia* v. *prolificans;* apothecia finally darkening.................................v. *lividorufa*
            Thallus thicker, lobes broad, 4–8 mm.; apothecia not darkening, reddish............................v. *pyrrhichocarpa*
      Laciniae sublinear, up to 4 mm. broad, short, rounded.
        Apothecia black; Jamaica..............................v. *genuina*
        Apothecia fuscous, ciliate..............................v. *strigoso*

Under side of thallus white with black-fibrillose margins, laciniae lacerate-imbricate . . . . . . *C. fibrillosa*
Under side of thallus white, rhizinae white.
Thallus isidiose.
Laciniae very narrow, 0.1–0.2 mm. broad, adnate . . . . . . *C. dominguensis*
Laciniae broad and flabelliform, up to 10 mm. broad . . . . . . *C. albida*
Thallus not isidiose.
Laciniae 150–200 μ broad, loosely adnate, bluish; rhizinae penicilloid, projecting beyond margin, dichotomous . . . . . . *C. tenuissima*
Laciniae 250 μ broad, tips ascending, bluish; long white rhizinae, palmate with lacinulae pinnatifid; apothecia carneous, rigidly white-ciliate . . . . . . *C. elegans*
Laciniae broader.
Thallus greenish blue, rhizinae rigid, white; flattened apothecia cerine-flavous . . . . . . *C. epiphylla*
Thallus lead-color or slightly bluish, crenate-squamulose, subimbricate, pterygoid; apothecia testaceous, white, ciliate . . . . . . *C. asterella*

COCCOCARPIA PELLITA (Ach.) Müll. Arg., Flora **65**: 320. 1882.

Parmelia pellita Ach., Lichenog. Univ. 468. 1810, Sw., Lich. Amer. 7, *pl. 6.* 1811.

Type: West Indies, *O. Swartz.*

Laciniae of thallus rather narrow, about 4 mm. broad, pinnatifidly incised, either discrete or approximate, smooth above; hypothallus well developed and extending beyond the thallus. Apothecia deep fuscous.

This species seems widely distributed and very variable in the tropics. Only a monographic study by one who has access to the types of all the proposed varieties as well as considerable experience in the field in the principal floristic areas of the tropics can finally decide the validity of the proposed varieties and forms and provide adequate descriptions so that others may recognize them. Nylander, Müller Argau, Hue, Vainio, and Malme have each attempted more or less elaborate revisions but none seems wholly satisfactory. While probably artificial the separation of *C. cronia* for all the isidiose varieties of this species is relatively easy to apply, and has been followed here.

Var. PARMELIOIDES (Hook. ap. Kunth) Müll. Arg., Flora **65**: 320. 1882.

Lecidea parmelioides Hook. ap. Kunth, Syn. Pl. Aequinoct. Orb. Nov. **1**: 15. 1822.

Type: Colombia, Cumana, Bordones, and Nueva Barcelona, *Humboldt & Bonpland.*

Thallus light olive gray, surface smooth, lobes cuneate, about 4 mm. wide, sometimes once-cleft, closely appressed to the substrate, held by a few dark brown to black rhizinae composed of fascicles of hyphae, about 200 μ thick; upper cortex about 25 μ thick, the outer 5 μ formed from the disintegration of a very thin layer of periclinal hyphae, the rest pseudoparenchymatous from the shifting of cells in a palisade layer, cells 10–12 μ in diameter, rather thick-walled; algal layer a palisade of hyphae and filaments of *Scytonema* about 100–120 μ thick; medulla about 40 μ thick, of large septate periclinal hyphae 5–8 μ in diameter; lower cortex of dark, periclinal conglutinate thick-walled hyphae 3–4 μ in diameter. Apothecia immarginate, appressed and more or less adnate, 2 mm. or more in diameter, disc black; no amphithecium; parathecium of periclinal thick-walled hyphae, giving a pseudoparenchymatous appearance, 100–120 μ thick, thinning out to about 20 μ at the edge; hypothecium not differentiated from the parathecium; thecium about 160 μ tall; paraphyses 2–3 μ in diameter, frequently septate, clavate tips black, about 4 μ in diameter; asci cylindric to somewhat clavate, 8-spored, about 60 x 8–12 μ; ascospores monostichous at first, gradually becoming distichous, ellipsoidal with acute ends, very thick-walled, unicellular, often with some deeply staining material in the middle with a slight thickening of the cell wall at that point, giving the appearance of a two-celled polarilocular spore with a wide isthmus, occasionally two other constrictions near the tip slightly suggesting a 4-celled condition, 11–12(–16) x 6–7 μ.

This variety seems widespread in the lower elevations although in absence of apothecia it is practically indistinguishable from var. *pyrrhichocarpa*. In Costa Rica var. *parmelioides* occurs in suitable habitats up to about 800 m., while var. *pyrrhichocarpa* occurs from 700 to 1340 m., but seen from Brasil up to 2000 m. in the state of São Paulo.

Limón: Waldeck, 40 m., *Dodge 7402*.

Guanacaste: H. Santamaría, 680–780 m., *Dodge & Thomas 4709;* C. San José de Libano, 500–960 m., *Dodge, Hanckel & Thomas 6684;* R. San José, 460–480 m., *Dodge & Thomas 6581*.

Puntarenas: Osa, Puerto Jiménez, *Brenes 825a;* R. Sándalo, *Dodge 7742*.

Var. PYRRHICHOCARPA Hue, Bull. Soc. Bot. France **48:** lx. 1901 [1902].

Var. *smaragdina* Müll. Arg., Flora **65**: 320. 1882, excl. syn. quoad specimina americana; Vainio, Étude Lich. Brésil **1**: 210. 1890; Malme, Ark. f. Bot. **20**[3]: 19. 1924.

Type: Brasil, São Paulo, near São Paulo, *Azevedo Sampaio.*

Thallus between yellowish glaucous and light mineral gray, lobing of thallus similar to var. *parmelioides* but much more irregular and lobes rather smaller, smooth above, 150–160 μ thick, upper portion of cortex 4–6 μ thick, of longitudinal hyphae soon disintegrating and disappearing, leaving a palisade 25–30 μ thick, which in turn becomes a somewhat irregular large-celled pseudoparenchyma; the algal layer 40–50 μ thick, of loosely coiled and disintegrating filaments, perhaps *Scytonema,* but the cells rounding up and suggesting *Nostoc,* about 8 μ in diameter, the medulla 50 μ thick, of large septate periclinal hyphae, somewhat less compact than in var. *parmelioides,* the lower cortex about 25 μ thick, of black somewhat smaller conglutinate hyphae; rhizinae much more abundant, smaller conglutinate fascicles of hyphae similar to those of the lower cortex. Apothecia irregular, 3–3.5 mm. in diameter, carnelian red to vinaceous rufous, only slightly darkening, never dark brown or black, immarginate; amphithecium absent; parathecium adnate to the upper cortex, about 100 μ thick, of large periclinal hyphae appearing almost pseudoparenchymatous at times; thecium 60 μ tall; paraphyses 2–3 μ in diameter, filiform, apex not enlarged; asci clavate, about 12 μ in diameter; ascospores 10–14 x 4–5 μ.

This variety is occasional at the medium elevations of the temperate zone in Costa Rica, ranging from 700 to 1400 m. It should not be confused with *C. smaragdina* Pers. or *C. molybdaea* Pers., both from the Old World tropics.

Cartago: R. Birrís near Santiago, 920–1340 m., *Dodge 4708, 8050;* Cartago, *C. Wercklé* (Mus. Nac. 172186 p. min. p.).

Alajuela: Santiago de S. Ramón, 1000 m., *Brenes 238.*

Guanacaste: H. Santamaría, 680–780 m., *Dodge & Thomas 6813.*

Var. STRIGOSA Müll. Arg., Flora **65**: 326. 1882.

Coccocarpia molybdaea v. *cronia* Nyl., Acta Soc. Sci. Fenn. **7**: 441. 1863, non Tuck.

Type: Colombia, Cune, 1200 m., *Lindig 2663 p. p.*

Thallus between pale olive buff and yellowish glaucous, lobes cuneate but narrower than in v. *parmelioides,* slightly incised,

smooth and shining above, thallus about 100 μ thick, outermost layer of hyphae about 4 μ thick, soon disintegrating, upper cortex pseudoparenchymatous, 10–12 μ thick, of about two layers of pseudoparenchymatous cells not part of a palisade, algal layer 32–40 μ thick, of curved hyphae in a disintegrating palisade (intermediate between v. *parmelioides* and v. *pyrrhichocarpa*), medulla 25–30 μ thick, of large periclinal hyphae, lower cortex 12–15 μ thick, of large black periclinal hyphae, closely agglutinated rhizinae abundant but hyphae less fasciculate. Apothecia about 2 mm. broad, ochraceous tawny at first, becoming Prout's brown or darker, immarginate; no amphithecium; parathecium about 100 μ thick, of large periclinal hyphae, at the margins many hyphae projecting beyond the general level as stiff hairs; hypothecium not differentiated and not deeply staining; thecium about 40 μ tall; paraphyses filiform with acuminate tips which extend 1–2 μ above the epithecial gel; asci clavate, 30 x 8 μ, with 8 spores; ascospores fusiform-ellipsoidal, 8 x 4 μ, thick-walled, probably still immature.

In the only collection from Costa Rica the thallus may not be quite mature, as no mature ascospores were found, hence the measurements may be a little small. Reported elsewhere only from Colombia.

Cartago: R. Birrís, 920–1100 m., *Dodge 8051.*

Coccocarpia cronia (Tuck.) Vainio, Ann. Acad. Sci. Fenn. **A6**[7]: 103. 1915.

Parmelia cronia Tuck., Proc. Amer. Acad. Arts & Sci. **1**: 228. 1848; Syn. Lich. New England, 36. 1848.

Coccocarpia molybdaea v. *cronia* Nyl., Syn. Meth. Lich. **2**: 41. 1863.

Coccocarpia pellita v. *cronia* Müll. Arg., Flora **65**: 321. 1882.

Coccocarpia parmelioides v. *cronia* Hue, Bull. Soc. Bot. France **48**: lx. 1901 [1902].

Type: United States, Massachusetts, Lynn Hills, and West Cambridge, on mossy rocks, *Tuckerman.*

Thallus mineral gray or darker, lobes rounded or short, broad-linear, more or less appressed, growing over mosses, about 130–140 μ thick; upper cortex 15–20 μ thick of large thin-walled hyphae often appearing pseudoparenchymatous; algal zone

30–40 μ thick, with loosely woven hyphae in which are imbedded solid little groups 15–20 μ in diameter of algal cells of closely coiled *Scytonema;* medulla 30–40 μ thick, partly of close periclinal hyphae, partly more loosely woven, the lower cortex of two layers of black thick-walled hyphae giving rise to rhizinae, sterile; isidia terete, concolorous, or somewhat darkened at the tips. Tuckerman noted on a specimen from Alabama, "spores 9–12 x 3–5 μ, 2-celled?"

Var. LIVIDORUFA (Mey. & Fw.) Zahlbr., Cat. Lich. Univ. **3**: 287. 1925.

Parmelia lividorufa Mey. & Fw., Nova Acta Acad. Leopold. Carolin. **19**: Suppl. 222, *pl. 4, f. 2.* 1843.

Coccocarpia molybdaea var. *tenuior* Nyl., ap. Krmplhbr., Flora **59**: 76. 1876 (nom. nud.).

Coccocarpia pellita var. *tenuior* Müll. Arg., Flora **65**: 321. 1882.

Type: Brasil, Rio de Janeiro, *Meyen* (Bot. Mus. Berlin), type of var. *tenuior;* same locality, *Glaziou 2026* (Univ. Genève).

Thallus mineral gray, lobes small, mostly about 1 mm. broad, quite irregular, smooth, about 100 μ thick, structure as in the previous variety. Apothecia immarginate, irregular, convex, disc snuff brown to bister; amphithecium absent; parathecium 130–140 μ thick; hypothecium not differentiated; thecium 80–85 μ tall; paraphyses filiform, ending in the epithecial gel; asci 8-spored, clavate to cylindrical, 12 μ in diameter, ascospores 11–12 x 5–6 μ, ellipsoidal, thick-walled, distichous.

In this variety the whole thallus approaches a microphylline squamose state. Evidently a lowland variety seen also from British Honduras and Nicaragua.

Limón: R. Siquirres, 70–200 m., *Dodge, Catt & Thomas 8058.*
Alajuela: La Palma de S. Ramón, 1100 m., *Brenes 43.*
Guanacaste: Tilarán, 650–690 m., *Dodge & Thomas 6557.*

Var. **isidiophylla** (Müll. Arg.) Dodge, comb. nov.

Coccocarpia pellita v. *isidiophylla* Müll. Arg., Flora **65**: 321. 1882.

Coccocarpia pellita v. *cronia* Vainio, Étude Lich. Brésil **1**: 209. 1890, et auct. recentior., non Tuck.

Coccocarpia cronia v. *primaria* Vainio, Ann. Acad. Sci. Fenn. **A6**[7]: 103. 1915.

Type: Brasil, Rio de Janeiro, *Glaziou 2025.*

Thallus mineral gray or darker, laciniate, flabelliform or cuneate with rounded margin about 4 mm. broad, sometimes somewhat incised along the margin, upper surface isidiose with either simple or slightly branched isidia which are confined to the central portion of the thallus and to a lesser extent of the lobes; upper cortex of large thin-walled hyphae perpendicular to the margins of the lobes, up to about 20 μ thick, closely septate; algal zone 60 μ thick of filaments of *Scytonema* about 12 μ thick with cells about 8 μ in diameter, in the lower portion the algae less crowded, leaving some air spaces, medulla not differentiated from the algal zone; lower cortex 30 μ thick, of conglutinate, black, thick-walled hyphae, giving rise to scattered rhizinae as well as penicillate fascicles of hyphae. Apothecia yellowish-rufous, becoming fuscous, somewhat lobulate, immarginate, adnate; parathecium 55–60 μ in the center, thinning out at the margin, pseudoparenchymatous, of large somewhat periclinal hyphae; hypothecium not differentiated, about 60 μ thick; paraphyses 2–3 μ in diameter, filiform, with swollen tips in the very dark epithecial gel; asci clavate, 8-spored, 8–10 μ in diameter; ascospores distichous, fusiform, immature.

This species is close to *C. pellita* and perhaps should be considered a variety of that species. It has approximately the same distribution, reaching from sea level to about 1700 m. in Costa Rica, 2700 m. in Perú.

Cartago: Aguacaliente, 1240–1460 m., *Dodge & Thomas 7087.*

Heredia: C. Central de Zurquí, 1600–1700 m., *Dodge, J. Valerio & Thomas 6087;* C. de las Caricias, 2000–2400 m., *Standley & J. Valerio 55282.*

Alajuela: La Palma de S. Ramón, 1100 m., *Brenes* (fertile).

Puntarenas: Osa, between R. Sándalo and R. Tigre, 1–2 m., *Dodge 8057.*

Var. **prolificans** (Malme) Dodge, n. comb.

Coccocarpia pellita var. *prolificans* Malme, Ark. f. Bot. **20**^{3}: 19. 1924.

Type: Brasil, Rio de Janeiro, *Regnell 65.*

Thallus mineral gray or darker, lobes flabelliform, somewhat zonate, 5–10 mm. wide, margin rounded, more or less lobulate along the incised portions between lobes, upper surface lobulate and more or less microphylline, lobules concolorous, about 70 μ thick, upper cortex about 16 μ thick, of large thin-walled longitudinal hyphae; algal zone about 30 μ thick, of a loose palisade

of *Scytonema* filaments, medulla about 20 μ thick, of large thin-walled periclinal hyphae with some air spaces; lower cortex about 15 μ thick, of thick-walled black hyphae, giving off fascicles of rhizinal hyphae. Sterile.

This variety is rather common at elevations from 700 to 1400 m. in Costa Rica.

Cartago: R. Birrís, 1220–1340 m., *Dodge & Thomas 4710.*

Alajuela: La Palma de S. Ramón, 1250 m., *Brenes 38a;* Piedades de S. Ramón, 900 m., *Brenes 385.*

Guanacaste: H. Santamaría, 680–780 m., *Dodge & Thomas 6987, 6999.*

Var. **granulosa** (Müll. Arg.) Dodge, comb. nov.

Coccocarpia pellita var. *granulosa* Müll. Arg., Flora **65**: 322. 1882.

Type: Brasil, São Paulo, Apiahy, *Puiggari 244,* and Colombia, Bogotá, 2700 m., *Lindig 2538.*

Thallus thicker, greenish-glaucous-blue or darker, lobes up to 3 mm. broad, the larger lobes more or less incised, obovoid to almost linear, soon blackish granular to almost isidiose in the center, about 140 μ thick, upper cortex a single layer of longitudinal hyphae 4–5 μ in diameter, algal zone of *Scytonema* filaments 40–50 μ thick, forming a palisade interspersed with occasional rows of fungal cells, medulla of large, septate, periclinal hyphae about 60 μ thick, the lower cortex 6–8 μ thick, of thick-walled dark hyphae, not well developed. Apothecia less adnate and somewhat isidiose; no amphithecium; parathecium 150 μ thick, pseudoparenchymatous, some of the outer layer of cells growing downward to form a ciliate to tomentose surface below; hypothecium not differentiated, thecium about 60 μ tall; paraphyses filiform, tips not enlarged, ending in a dark brown epithecial gel; asci clavate, rather immature.

This variety as here defined includes some of Malme's var. *isidiosa* and some material may have been distributed under that name. In Costa Rica this variety is widespread in the temperate regions from 100 m. to 1500 m.

Limón: R. Siquirres, 70–200 m., *Dodge, Catt & Thomas 5595.*

Cartago: Santiago, 1140–1180 m., *Dodge 4638, 8054;* C. Carpintera, 1320–1500 m., *Dodge & Thomas 4763;* Cartago, *C. Wercklé* (Mus. Nac. 17202).

San José: Turrúcares, 540–600 m., *Dodge & Thomas 8056;* R. Virilla below El Brazil, *Dodge 7777.*

Alajuela: C. Pata de Gallo a S. Rafael de S. Ramón, 1200–1250 m., *Brenes 215;* S. Pedro de S. Ramón, 700 m., *Brenes 459.*

Guanacaste: Liberia, 100 m., *Dodge & Thomas 6582;* H. Santamaría, 640–780 m., *Dodge & Thomas 6900, 7007, 8055;* Tilarán, 650–690 m., *Dodge & Thomas 6556, 6559, Standley & J. Valerio 44429, 44520;* H. Granadilla, between R. Las Cañas and R. S. José, *Dodge & Thomas 6719.*

COCCOCARPIA **albida** Dodge, sp. nov.

Type: Costa Rica, Limón, Hamburg, *Dodge & Nevermann 7401.*

Thallus albidus, isidiosus, lobis rotundatis, flabelliformibus, 10 mm. latis, zonatus, inferne albus rhizinis albidis, apicibus rhizinarum nigricantibus, thallus 120–130 μ crassitudine, cortex 15 μ, hyphis longitudinalibus septatis, 5–6 μ diametro; zona scytonematica ad 40 μ crassitudine, filamentis laxis implexis, medulla 40–60 μ crassitudine hyphis periclinalibus compactis; cortex inferior hyphis hyalinis dense compactis; rhizinis albidis fasciculatis penicillatis.

Thallus mineral gray or lighter, densely isidiose in the center, lobes rounded, flabelliform as in *C. pellita* v. *parmelioides*, 10 mm. broad, more or less zonate, below white with white rhizinae, the latter sometimes tipped brownish black; thallus 120–130 μ thick, cortex 15 μ thick, of longitudinal septate hyphae 5–6 μ in diameter; algal zone 40 μ thick, of loosely tangled filaments of *Scytonema*, medulla 40–60 μ thick, of compact periclinal hyphae; the lower cortex of hyaline hyphae more or less agglutinated; rhizinae white, fasciculate, and penicillate.

The lower surface resembles that of *Sticta* sp. quite closely, but cyphellae are absent and the structure is typical of *Coccocarpia.* Perhaps it is an albino variety of *C. cronia* var. *isidiophylla.* It has much broader lobes than *C. dominguensis.*

Limón: Hamburg, 20–30 m., *Dodge & Nevermann 7401.*

COCCOCARPIA ELEGANS Müll. Arg., Flora **64**: 507. 1881.

Type: Brasil, São Paulo, Apiahy, *Puiggari.*

No hypothallus, thallus terre-verte, small, linear, dichotomous (rarely trichotomous at the ultimate branches), larger laciniae 0.1–0.2 mm. broad, ultimate branches much narrower, dull and smooth above, white with white rhizinae below, thallus 80–85 μ thick, upper cortex 8–12 μ thick, decomposed, apparently of slender longitudinal hyphae; algal layer about 40 μ thick, irregular, of loosely woven fungus hyphae supporting short irregular chains of angular to subspherical cells 8–12 μ in diameter, medulla not well differentiated from the algal layer but of very loosely

woven slender hyphae; lower cortex 10–15 μ thick of closely woven hyaline, longitudinal hyphae, the rhizinae 40–50 μ in diameter, large fascicles of hyaline hyphae. Apothecia immarginate, 0.1–0.5 mm. in diameter, chestnut, with long fascicles of hyphae forming stiff bristles about the margin, with stipe about 200 μ in diameter and 40–50 μ tall; no amphithecium; parathecium 60 μ thick, of thick-walled hyphae forming pseudoparenchyma; thecium 60 μ tall; paraphyses slender, filiform, not enlarged at the tips; asci clavate, 4–6 μ in diameter, immature.

The above description is based upon material from Brasil, Rio de Janeiro, *Glaziou 18071*, determined by Müller Argau, who also reports it from Puntarenas, Boruca, 560 m., *Tonduz 5462*. As this is a small epiphyllous species, a large thallus being only 1 cm. in diameter, it is quite possible that it has been overlooked as my epiphyllous material has not yet been examined carefully.

A NEUTRAL (?) STRAIN OF MUCOR SPHAEROSPORUS FROM MISSOURI

MORRIS MOORE

Formerly Rufus J. Lackland Research Fellow in the Henry Shaw School of Botany of Washington University

In the caves of the Ranken estate in Missouri, where the atmosphere is moist and the temperature approximately 16° C., was found a segment of a twig matted with a growth of mycelial threads, white in a mass, and hyaline when single. The appearance of the latter was that of many fine root hairs. When transferred to agar substrates, numerous sporangia, sporangioles, oidia, and chlamydospores developed, with no evidence of zygospores. The characteristics and description were similar to those given by Lendner ('08) for *Mucor sphaerosporus* Hagem 1908.

This fungus has been reported chiefly from Europe, and in this country by Waksman ('16) and Gilman and Abbott ('27), as isolations from soil. As far as the author could determine, this is the first report of the above organism from Missouri.

A culture sent to Dr. A. F. Blakeslee at the Carnegie Institution of Washington, Department of Genetics, was tested with strains of presumably the same species, one being a minus isolated by Waksman in 1915, and another a plus strain probably from the Centralstelle, of unknown origin. No zygospores were produced. An attempt was made to obtain imperfect hybridization by treating this strain with some of the strong testers in the above laboratory, but no sexual reaction resulted. Growth on various media produced changes in the amount of mycelium, size and number of sporangia, sporangioles, hyphae, oidia and chlamydospores, and in chromogenesis.

Thanks are due Dr. Blakeslee and Miss Satina of the Carnegie Institution of Washington for their interest and assistance.

BIBLIOGRAPHY

Gilman, J. C., and E. V. Abbott ('27). A summary of the soil fungi. Iowa State Coll. Jour. Sci. 1: 225–343. 1927.

Lendner, A. ('08). Les Mucorinées de la Suisse. Matériaux pour la flore cryptogamique Suisse 3^1: 1–177. *pl. 1–3.* 1908.

Waksman, S. A. ('16). Soil fungi and their activities. Soil Sci. 2: 103–156. 1916.

A STUDY OF ENDOMYCES CAPSULATUS REWBRIDGE, DODGE AND AYERS: A CAUSATIVE AGENT OF FATAL CEREBROSPINAL MENINGITIS[1]

MORRIS MOORE

Formerly Rufus J. Lackland Research Fellow in the Henry Shaw School of Botany of Washington University

Introduction

The probable taxonomic relationships of the fungi known as yeast-like organisms have for many years attracted much attention and discussion among mycologists, and to a certain extent among medical men. Considerations of their general physiological properties, modes of reproduction, their cytological differentiations, and varied pathogenic abilities were involved. The group comprises several families and many genera and species, with subdivisions of these, which from time to time call forth long and expounding dissertations on the mechanism of reproduction (the perfect stage). The problem of classification is unfortunately a very complex one, since it has been found, at least in the present work and with other closely related fungi which will be considered later, that several forms of development may be present in the same culture. Such phenomena are rather rare but render incorrect any means of classification based on one phase only.

It is well known that the fungi are divided, on the basis of their morphology, cytology, and sexual development, into three major divisions: Phycomycetes, Ascomycetes, and Basidiomycetes, and to these is appended a fourth group, the Fungi Imperfecti, the life history of which is not at all or incompletely known. The yeast-like organisms are considered to constitute a branch of both the Ascomycetes and the Fungi Imperfecti, the former where the production of asci is found, and the latter where no sexual development has been determined. More specifically, the perfect forms are considered to be members of the Endomycetaceae (Gaümann and Dodge, '28; Rewbridge,

[1] An investigation carried out at the Missouri Botanical Garden in the Graduate Laboratory of the Henry Shaw School of Botany of Washington University, and submitted as a thesis in partial fulfillment of the requirements for the degree of doctor of philosophy in the Henry Shaw School of Botany of Washington University.

Dodge, and Ayers, '29; Moore, '33), and Coccidioideaceae (Moore, '32), including such genera as *Endomyces*, *Coccidioides*, *Rhinosporidium*, and *Pseudococcidioides*, while the imperfect forms, as *Monilia*, *Cryptococcus*, *Oidium*, *Mycoderma*, and several others have features which are somewhat similar to the above groups. This of course does not include the true yeasts which are included under the Saccharomycetaceae.

It was because of the imperfect knowledge existing in the field that the author undertook the study of the cytology of *Endomyces capsulatus*, which had been isolated from a case of meningo-encephalitis. During the course of the work it was found desirable to learn more about the phenomena which might be associated with the pathogen, and hence attention was paid to its physiological and other properties. In addition, the occurrence of other infections by closely allied organisms, *E. capsulatus* var. *isabellinus* (Moore, '33), and *E. dermatitidis* (Moore, '33a), have yielded the fungi which have been used in a comparative study, so that what may pertain to *E. capsulatus* has been found to hold true for the latter, with some minor exceptions as chromogenesis and cultural characteristics.

Historical Review

Occasionally debatable points in the field of medical mycology are cleared up by the isolation of some fungus. Such an organism, *E. capsulatus*, was cultured in 1928 from a case of meningitis. The patient was a white, married male, 48 years of age, a furrier by trade. He entered the Boston City Hospital in August, 1928, complaining of having had continuous headaches in the frontal and temporal lobes for a period of three and a half months. His illness began with a hard, tender, slightly movable mass on the medial surface of the lower third of the left thigh, about five months before entry. This mass subsided within four weeks, but a similar mass then appeared beneath the anterior surface of the neck. He developed defects in memory, losing himself on familiar streets, and could not keep track of time. He lost interest and was unable to understand questions or conversation.

The cyst which had been present at the level of the thyroid isthmus between the trachea and anterior border of the sterno-

cleidomastoid muscle was aspirated. Thirty cc. creamy, tenacious, yellow pus was obtained, from which *E. capsulatus* was cultured. Similar organisms were obtained from the pus aspirated from the nodule of the left thigh.

About a month later, the patient's condition became worse. His temperature increased rapidly, as did his pulse and respiration, and he finally died. The clinical diagnosis was mycotic meningo-encephalitis (?), and an X-ray diagnosis showed bilateral pulmonary tuberculosis. It has been the author's experience that an infection of this sort which involves the lungs is often mistaken for tuberculosis, and the diagnosis made here may have been incorrect. The organism from this case has been used in these studies for the greater part, having been kept as a stock culture by alternate transfers on nutrient and Sabouraud's agar.

The second case due to the variety *isabellinus* (pl. 21) occurred in St. Louis and was reported by MacBryde and Thompson. The patient, a white male, 28 years of age, had been a plumber at the time of the appearance of the skin lesions. He was first admitted to the Barnard Free Skin and Cancer Hospital in February, 1930, with a palm-sized annular ulceration on the left forearm just above the wrist, which involved the dorsal surface chiefly and showed clinical signs of blastomycetic dermatitis. Endomycetes were isolated from the pus of this lesion. About 3 cm. to the right of the anus was another lesion about 3 cm. in diameter and involving the anal margin. On the upper part of the right arm was a scar of a lesion which had healed spontaneously. All active lesions were pruriginous and had a foul smell. The patient later, in January, complained of coryza, with a mild cough, pain in the right temporal region, accompanied by a rise in temperature. His headache became universal and intense, posterior to the eyes and extending to the occiput and base of the neck. There was a marked bilateral Kernig reflex action. He had nauseation and vomiting spells. A lumbar puncture gave a cloudy fluid under slight pressure, in which were seen the organisms found in greater abundance with later punctures. At this time he received a large dose of iodine solution which cleared the spinal fluid and decreased the number of budding cells, improving

his health greatly. However, two weeks later he had a relapse, became comatose, and three days before death developed three small subcutaneous abscesses. One was on the right wrist, one on the sacrum, and one on the left side of the chest, and all contained pus and *E. capsulatus* on culture. The patient died forty-six days after the onset of the meningitis symptoms and about three years after the first appearance of the skin lesions.

The morphology and cytology of the organism of this case was found to be the same as the first fungus, having a very light cinnamon color as contrasted with the hyaline or white, in a mass, of *E. capsulatus*, and cultural characteristics similar in detail.

The third organism studied is the one which has gone under many generic names, as *Blastomyces*, *Oidium*, *Saccharomyces*, *Cryptococcus*, and *Mycoderma*, because its life history was incompletely known and the sexual act was not definitely established, or the presence of the ascus and the actual number of spores determined. Historically this fungus is important because it causes a disease known as blastomycosis which has become fairly widespread, both in this country and Europe. The organism studied by the author was isolated from a case which occurred at the Barnard Free Skin and Cancer Hospital of St. Louis and has been dealt with in detail in a previous paper (Moore, '33). Suffice it to say here that *E. dermatitidis*, the organism causing a clinical condition known as blastomycosis, is similar to the above organisms, differing in its chromogenesis, being a dark cinnamon to brown in culture and having a somewhat different cultural reaction, to be mentioned later.

In addition to the above three forms, an organism obtained from a case of the so-called European blastomycosis or generalized torulosis reported by Urbach and Zach ('30) (pl. 19, figs. 13–25) has been studied to a certain extent. The case in brief was that of a 27-year-old shoe-worker who had never left Europe. He entered the University Clinic for Syphilology and Dermatology at Vienna with a swelling of the gums of the lower jaw which was excised, and a half year later he returned with a similar swelling of the gums of the upper jaw. About one year later the patient noticed an abscess-like swelling on the left side of the abdominal region, two months later a similar disorder on

his left thigh, and eight weeks later the same thing was found on his neck. The lesion on his left thigh was aspirated and from it 200 cc. purulent substance was obtained. A short time after that an inflammation of the lungs developed which healed spontaneously, but left him with a cough and vomiting spells. Yeast-like cells were cultured from the purulent secretion of the left thigh.

The disease was clinically identical with syphilis, tuberculosis, leukemia, and several others. Inoculation of an extract of the yeast-like cells (blastomycin) brought forth strong local, focal, and generalized reactions, giving evidence of the presence of blastomycosis.

The lesions were somewhat superficially healed by treatment. The patient later developed high temperatures in the evening, oral pains, deafness, violent coughing at night, and ruby-red expectorations. A tumor of the nasal septum, very suggestive of rhinosporidiosis, had developed and a catarrh of the Eustachian tube as a result of the tumor. There was an ulceration of the right tonsil and other lesions close by, and finally a heavy exudate in his lungs. Treatment gave him relief temporarily, but he returned to the clinic a short time later with a continuous headache, high temperature, and rapid spread of the mouth lesions. Paralysis of the optic musculature set in, with unconsciousness, and death ensued.

The organism from this case has been cultured and subcultured and as yet has shown no final stage as is present in the three above forms. However, some organisms require a long time before the perfect stage is obtained. Furthermore, the histological and pathological condition of the patient as investigated by Chiari ('30), shows the identical tissue reaction present in cases of *E. dermatitidis*.

With this brief review of the history of the organisms investigated, let us now turn to a study of *E. capsulatus*.

Technique

E. capsulatus was kept growing by subculturing on nutrient and Sabouraud's agar as a stock culture. In the work done here, the organism was grown on nutrient agar, a product of the

Digestive Ferments Co., at pH 6.8. In cases where an abundant growth was necessary, with a thick mycelium, Sabouraud's agar, pH 5.6, was employed.

For studying the cytology with regard to the nuclear changes in the sexual act, glycerine agar (beef extract agar plus 6 per cent glycerine, pH 7.1) was used. This medium gave the greatest number of asci in culture, in addition to a thick growth and many important diagnostic features, as chlamydospores, conidia, racquet mycelium, etc. Cultures on nutrient agar and Sabouraud's agar were also used, but the cells were not so good for details as on the above medium.

The cultures were fixed with a number of agents. Flemming's stronger solution shrunk the material rather noticeably, but the weaker did not give very good results either. Bouin's picro-formalin solution, which has been advocated by Kater ('27) and other cytologists working with yeasts, was of no value in this work. Benda's fluid, which is a modification of Flemming's stronger solution, caused the fungus to have too great an affinity for the stains, and inasmuch as it is difficult to destain the organism without causing some sort of damage, it had to be used with caution. Hermann's fluid, which is probably the most expensive of the fixing agents, was also used. This is a variation of Flemming's fluid, the chromic acid being replaced by platinic chloride, and although not particularly recommended by Chamberlain ('32), the author has found it to give the best results. Various other fixing agents were employed, but the results were not worthy of note.

The embedding proved to be a problem because the material had to be fixed and embedded while on the agar. Paraffin was used at first, but in the glycerine agar cultures it would not adhere to the agar substrate and sectioning could not be done without damage to the material. Gradual and repeated changes of paraffin did not remedy the condition. A medium was then tried which contained very little protein and carbohydrate, but no suitable growth could be obtained. Finally the cultures were embedded in Dupont parlodion, using the Jeffrey technique. This method has been recently outlined by Wetmore ('32) and with some modification was applied here. It consists in fixing

the material, in this case either with Hermann's or Benda's fluid, pumping and dehydrating, then passing it through an intermediate stage of ether-alcohol, and then through a series of concentrations of the celloidin or parlodion. The first concentration was a 2 per cent solution and each series increased 2 per cent until the final concentration was 12 per cent. The material on the agar was taken from the test-tube after fixing, cut into convenient pieces, and put through the above procedure. The pieces were kept in a tightly plugged bottle in an incubator at 45° C. and changes were made daily. After embedding, sections were cut to a thickness of 10 μ. These were then stained and mounted.

The best stain for this procedure was found to be iron-alum haematoxylin, using Heidenhain's haematoxylin, although Ehrlich's gave just as good results. A combination of Benda's fixing agent and iron-alum haematoxylin showed the reticulated network and the metachromatic material very well, whereas Hermann's fluid plus Heidenhain's iron-alum haematoxylin was best for nuclear structure. Methylene blue and Hermann's fluid brought out the vacuoles and volutin and the metachromatic material very clearly, as seen in pl. 23, figs. 15–18.

For morphological work, hanging-drop cultures were made of 2 per cent proteose peptone and 2 per cent bacto-peptone, as well as lactose broth cultures. Material was also placed in a drop of a 1 per cent solution of crystal violet (aqueous) in glycerine, the dye being added to the desired intensity. The preparation was allowed to stand from 15 to 30 minutes for a sufficient clearing. Aman's lactophenol was also applied, as was carbol fuchsin and very dilute solutions of methylene blue, eosine, and crystal violet. In addition, iodine potassium iodide (saturated solution) was used for studying the glycogen contents of the cells and chondriosomes, as advocated by Guilliermond. Osmic acid, platinic chloride, and iodine green were also used, as well as neutral red, but these materials and other methods of procedure will be explained later in the text.

Cytology

The cytology of the lower Ascomycetes, particularly the yeasts

and the yeast-like organisms, had been for a number of years a topic of discussion among the older cytologists. The question as to whether or not a nucleus was present was indeed a serious one, judging by the numerous and lengthy dissertations on the subject. As is customary, there were two sides to the argument. One group maintained that the cells, of the yeasts in this case, were made up of a mass of protoplasm and of nuclein, without a true nucleus, and that the nuclein is differentiated at times in the cytoplasm in the form of granules which assume a definite color on staining. The other group favored the presence of a definite nucleus.

The first reference to a nucleus in yeasts was perhaps made in 1844 by Nägeli, who decided that "a little nucleus of whitish mucus, lying on the membrane, regularly in each cell" (Wager, '98), was often found in the yeast cell. Whether Nägeli actually saw a nucleus in the fresh condition is rather doubtful, for an oil globule has often been mistaken for the nucleus even to-day, with our more advanced knowledge of cytology.

About five years later, in 1849, Schleiden, by treating cells with ether-alcohol or potash, was able to find a rounded structure with a clear cell wall which contained delicate granules either singly or in groups, and in addition, a large flat body, which he called a cytoblast.

Following this work, Brücke, in 1861, asserted that in living material, as well as dead cells treated with iodine and acetic acid, no definite nucleus could be seen and he reprimanded the former workers by saying that no one was justified in taking bodies of various sizes and numbers, such as often occur, for nuclei.

In 1879 Schmitz, using haematoxylin, was able to demonstrate a nucleus in the cytoplasm of the cell near the vacuole, while Strasburger, repeating this work in 1884 and 1889, using picric acid and haematoxylin, was able to confirm these observations, finding that the nucleus was not demonstrable in unstained material.

Krasser, in 1885, contradicted these findings by saying that granules existed in the yeast-cell, but no nucleus. His main argument was that there was no specific staining reaction for nuclei, and furthermore that the absence of a definite nucleus

in the yeast-cell was supported by the rapid growth of the organism. For this reason he believed that there was nuclein in the cell which was distributed through the protoplasm very much as is generally held to be the case with bacteria to-day.

Other workers who held the view that a nucleus, or at least a "corpuscle" as some called it, was present, the biochemical properties and physiological functions of which were analogous to those found in the cells of plants and of animals, were Hansen, Strasburger, Zacharias, Moeller, Buscalioni, Henneguy, Dangeard ('93), Janssens ('02), and Janssens and Leblanc ('98). In fact, the latter writers made the following statement, "*La cellule de la levure peut être considérée comme formé sur la type général de la cellule.* On y trouve en effet, un *noyau*, un *protoplasme* et *une membrane.*" To these workers the nucleus had a vacuolar appearance with a very differentiated structure, to others it was a homogeneous body. Wager ('98), in a detailed bit of work, described it as being a vacuole filled with chromatin granulations (perhaps somewhat as is shown in pl. 23, figs. 17–18) which had been taken for a nucleus by Janssens and Leblanc, and furthermore that a spherical and homogeneous body, considered by some as the nucleus, was always adjacent to the vacuole and could be compared with a nucleolus. He considered the vacuole plus the eccentric nucleolus as a primitive stage in the phylogeny of the development of the nucleus. This belief was also based on the observation that the small body and the vacuole divide simultaneously by budding.

Guilliermond, in 1902, demonstrated that a definite nucleus was present, and that the vacuole was independent of the nucleus, being filled with granulation products which at the present time he holds to be nuclear decomposition substances (nucleic acid derivatives with some unknown base). For the granules he retained the name "corpuscules métachromatiques," a term which had been applied previously and which is used even now.

Those who denied the presence of a nucleus but admitted the presence of a nuclein substance as described above were Raum, Roncali, Hieronymus, Macallum, and others.

In accordance with the views of the older writers, the author has found that in *Endomyces* as treated here, when first isolated

from the tissue of the host, no nucleus exists, but simply a distribution of the chromatin material or nuclein or metachromatic corpuscles throughout the cell, as may be seen in pl. 19, figs. 13–14, pl. 20B, pl. 21, figs. 1–3, and several others. This feature is a quite constant character of freshly isolated cells. However, when kept on agar or an artificial substrate, the cells not only change their form, passing through what may be termed the secondary stage, that is changing from a yeast-cell to a hyphal form, but also undergo a change in nucleoplasmic make-up. It has been found that even though the yeast-like cells retain the same morphological characteristics on agar media, their chromatin material or nuclein is converted into a definite nucleus. This was clearly shown to be the case in *E. dermatitidis* (Moore, '33). What the mechanism involved here might be, it is difficult to say, but we may conjecture that it is linked up with the adaptation to a changed environment and a different mode of development to which it must become accustomed, as shall be pointed out later.

With such views being held in the past, it was of course to be expected that the presence of any phenomena which might involve the nucleus, as mitosis, would also be in dispute. In yeasts the question of nuclear division has received considerable attention, particularly by Guilliermond, Dangeard, and several others, the former writing many and long papers on the subject, and it has been said by some present-day workers, and the following is a direct quotation from the papers of one of them, that "the ideas of Guilliermond . . . which gain weight by the mere bulk of his work on yeast, seem to meet with more favor."

The problem of the division of the nucleus in yeasts is perhaps more complex than would seem offhand. The same writers who held that a nucleus was present in the cell first described nuclear phenomena. Wager ('98) interpreted an amitosis in the yeast with perhaps evidence of chromosomes. Janssens and Leblanc ('98), working with *Saccharomyces cerevisiae* and *S. Ludwigii*, as well as *Schizosaccharomyces octosporus* and *S. Pombe*, described a form of mitosis which, in the light of other works, seemed very suspicious and they made the following statement, "On peut dire que tout ce qui diminue la vitalité d'une cellule tend à réduire la complication des phenomènes de division."

Dangeard ('93) found that the nucleus elongated and the nucleolus divided in two by an elongation to a thread-like process within the nuclear wall. Swellengrebel ('05) and later Fuhrmann ('06) ascribed a definite mitosis to the nucleus, the latter studying *Saccharomyces ellipsoideus* I. Hansen and presenting a typical karyokinetic sequence with the formation of four chromosomes. There were several authors who held to this view, and at present there are those who believe that definite mitotic phenomena are present. Kater ('27), using a smear technique with *S. cerviciae* [sic], demonstrated a mitosis, with the formation of about eight chromosomes and a definite spindle, instead of division by constriction. It should be pointed out here that smear methods as applied to yeasts and particularly as carried out by Kater have never yielded any results which might be considered reliable. The act of smearing, no matter how good or how careful the application of the fixative might be, usually allows for some action on the cell wall that obliterates the correct phenomena and substitutes artifacts, so that vacuolar constituents or secretion products of the cytoplasm have been misinterpreted.

On the other hand, Guilliermond ('17), in a summary of his work, found amitosis to occur where budding was present. This process was characterized by an elongation of the nucleus which quickly divided by the resorption of the thread-like portion that separated the two segments. Guilliermond also observed that it was impossible to see the nuclear phenomenon clearly due to the abundant products of secretion which covered the nucleus. The observations of Kohl, of Wager and Peniston ('10), and of Pénau confirmed Guilliermond's results, and even went so far as to actually claim definite amitosis.

Whether or not mitosis or amitosis actually occurs is still a matter of dispute, despite the evidence that either side may advance. There are several factors which must be considered in studying the process, or processes, in nuclear division. First, does the nucleolus have a single morphological characterization, such as exists in the higher forms, or does it constitute the total nucleoplasmic material, as some call it, which has an affinity for iron haematoxylin, for example, as in pl. 22, fig. 18? Second,

can the nucleus be seen so clearly that there is no mistaking the change that may take place during the actual process? The first question is difficult to answer because it has been found by several workers studying the chemistry of the cell, yeast or yeast-like or even that of the higher Ascomycetes, that certain materials take the same dye. Then, the linin network with the chromatin material or the chromomeres, as some call them, usually cause confusion. The second question is really serious, because we know that our most precise methods of technique are still too crude for the minute nuclear make-up of these lower Ascomycetes. Cell substances, or secretion products as Guilliermond calls them, usually take stains which are peculiar to the nucleus and mask any clear-cut pictures of nuclear phenomena, and nucleic acid substances, derivatives of excretion products of the nucleus, probably nucleophosphates and the like, are also substances that must be considered in detail. Besides, the size of the reactors in the process is too small for any precise determinations with the means at hand.

On the other hand, according to the theories of modern genetics there must be some mechanism whereby chromatic substance or material is distributed through the agency of mitosis, whereas the act of amitosis is simply a means of increasing the nuclear surface or spreading the nuclear material through a cell and is comparable to the fragmentation or lobulation of nuclei. The latter is not at all reproductive in this respect. However, there are many acts taking place in the daily life of a fungus, particularly in these lower groups, which are impossible to explain with our present knowledge of cytology or genetics, and theories have been built up only to be torn down and built up again. This does not mean that genetics is not standing on firm ground, but that much more must be learned about mycological phenomena before any generalizations can be made.

It is difficult to understand that the nucleus in the hyphae of yeast-like organisms, *E. capsulatus* or *E. dermatitidis*, divides by direct division, at least as far as can be made out from the nuclear appearance. The process is evidently very rapid, for an examination of a great many slides failed to show any condition other than that shown in pl. 22, figs. 3–5. In the

ascogenous hyphae, or perhaps the antheridium and ascogonium (pl. 22, figs. 6–9), the division is somewhat slower, and here an elongation of the nucleus and nucleolus may be seen with a deeper staining central portion indefinite as to character but perhaps analogous to chromosomes.

In a discussion of nuclear phenomena, the next thing to be considered is the mode of development or reproduction. Guilliermond ('05, '05a, '05b, '08, '09, '09b, '10, '10a, '10b, '11, '11a, '12, '13, '17, '19, '20), Dangeard ('93, '94, '94a, '94b, '97), Hansen ('04), and several others, in a long series of investigations, have described the sexuality of the lower yeasts and some of the yeast-like fungi. It is known, of course, that in the Ascomycetes, particularly the lower forms, there may be three forms of development, heterogamy, isogamy, and a reduction to parthenogenesis. In the first case, two gametes, usually of unequal size, a small one generally representing the antheridial cell and a larger one the ascogonium (this is not a hard and fast rule), send out one, or sometimes several, small tubes which copulate and fuse. The cell contents of the antheridium then pass into that of the ascogonium. The two nuclei, one from each gamete, fuse, and finally an ascus develops through the subsequent division of the fusion nucleus, the presumptive mother spore. In the case of isogamy in the yeasts, two morphologically alike gametes fuse in like manner. Finally in the series, there is a reduction to a condition in which a cell may suddenly produce spores without copulation. This condition has been found by Mangenot ('19) for *E. Lindneri* and by Guilliermond for several other species, as *E. fibuliger* and *Zygosaccharomyces Pastori.* It occurs also when an ascogonial cell sending out a tube or tubes fails to copulate and hence produces spores parthenogenetically.

In some species the above phenomena may be found separately, or two processes or even all three may be present in the same culture. This latter condition has been found to be true for *E. capsulatus.*

In addition to the parthenogenetic formation of asci and ascospores, there is a non-sexual reproductive structure which has not been given too much attention in the past. This is the conidium (pl. 23, fig. 10), which is a non-nucleated structure

filled with chromatin granules or the metachromatic corpuscles emphasized by Guilliermond. It occurs usually near a septum of the hypha, and measures approximately 5 μ in diameter. Structures of this sort may and usually do spring up from the hyphae when there is a lack of nutrient material, or when the hydrogen-ion concentration is fairly high (pl. 19, figs. 4, 7–8, 11–12). These may be pyriform (pl. 18, fig. 10) or round (pl. 18, fig. 7), sessile or on a short pedicel, with a thick wall (pl. 23, fig. 10) or a thin wall. There is a heavy reticulated network with the granules mentioned above usually occurring at the nodes of the threads. These particular structures break off easily and may serve as resting cells or chlamydospores which, when placed in favorable media, germinate, form nuclei by an accumulation perhaps of the chromatin material, and develop a normal growth. They represent probably a degeneration from an ascus, or, on the other hand, an advanced character of reproduction.

To get a clearer understanding of the life history of *E. capsulatus*, it would be advisable to begin with the organism as it is found in the parasitized host and explain the mechanism by which it and related fungi propagate themselves.

In the tissue the organism grows as a yeast 6–8 μ in diameter, and reproduces itself by budding. There is no nucleus present, at least it could not be demonstrated in tissue sections or in freshly isolated cells, but instead there is a distribution of nuclein material throughout the organism, much the same condition as exists in bacteria, Myxophyceae, or in the conidium shown here. When isolated and grown on an artificial substrate as on agar, the chromatin or nuclein material seems to become larger, and there is usually formed a nucleus and many large granules which may be presumptive nuclei. This latter condition is based on circumstantial evidence (pl. 21, figs. 4–9; pl. 20B). The cells then pass through this stage, the yeast-cells, to stage two which consists of large irregular cells, attaining a condition as seen in pl. 19, figs. 14–15, 20–25, and have been clearly shown for *E. dermatitidis*. At this stage the chromatin material is spread throughout the cell, but the reticulated network seen in the later stages is not very clearly established. However, it seems to be rapidly developing and nuclei are clearly distinct. The stage

following is probably the most complex of all, inasmuch as there is a diversity in morphology and cytology, changes due probably to hydrogen-ion concentration and temperature and several other factors among which the changed habitat is outstanding. In this third and final stage, we find that sexuality has developed and asci with ascospores are produced. To follow the life cycle on an artificial substrate, it would then seem best to follow the development from the germinating ascospore. In doing this, it is necessary to consider first normal growth on some favorable medium, and second to correlate the nuclear changes in material fixed in hanging-drop preparations (Van Tieghem cells) and stained, with the nuclear phenomenon found in the material fixed and stained as outlined in the technique. It was noticed that from three to fifteen days were necessary for the life cycle of the fungus to be completed, depending on the broth used in the hanging-drop preparation.[2] It was found that proteose peptone broth gave good growth as did lactose broth, but that bacto-peptone plus bacto-beef gave quickest development of asci, from three to five days usually. The material was fixed by the addition of two or three drops of a fixative described previously, and after a period of from six to eight hours, or over night, the fluid was drawn off with filter-paper and the material was carefully washed with distilled water and then mounted in lacto-phenol plus crystal violet, or stained with iron haematoxylin. By keeping several of these hanging-drop cultures growing, it was possible to obtain different stages of growth, even in one preparation. The method was of course not entirely accurate cytologically, but it served the purpose as demonstrated here.

The single spore (2–2½ μ) is found to be made up of densely staining granular material, but the granules are so small that it is difficult to discern them. On germinating, a tube is sent out or the spore simply elongates, taking with it the chromatin material (pl. 22, figs. 1–2). When somewhat older, the developing hyphae produce nuclei which divide rapidly as pointed

[2] Several solutions were used: lactose broth (product of Digestive Ferments Co.), pH 6.8; 2 per cent bacto-peptone broth, adjusted to pH 7.0; 2 per cent proteose peptone broth, pH 7.0; bacto-peptone plus 6 per cent glycerine; meat extract broth, pH 7.1; 2 per cent bacto-peptone plus 5 per cent bacto-beef (dehydrated), pH 7.2.

out previously, are distributed in pairs very close together, and then separate (figs. 3–4). At this time the reticulum is well developed and the chromatin granules, or basophilic grains, as Guilliermond calls them and which he believes probably represent albuminoid bodies playing the rôle of products of nutrition in the form of perhaps zymogen or reserve material, are very evident and take a deep stain with haematoxylin. At the same time, the wall increases in thickness and becomes fairly evident as in fig. 4. The number of nuclei in the hyphae varies, as many as thirty-seven having been counted on one hypha, but this was apparently rare for the amount usually varied between seven and fifteen with nine the most common, as in fig. 4. With the elongation of the new hypha, septa are laid down (fig. 5) and the formation of conidia as described previously (pl. 22, fig. 5; pl. 19, fig. 4) may be and usually is associated with this act. Following this, the hyphae, varying from 1½ to 4 μ on different media, may grow out to form branches or reproductive structures, usually lateral or terminal. However, on acid media or on media where there is a definite lack of some suitable protein or protein product in the form of peptone, peptides, or amino acids, there is an excessive formation of chlamydospores, either terminal (hypnospores), 4½–6 x 9–12 μ, or lateral, 5 x 7 μ, or intercalary, approximately 5 μ in diameter, and conidia (pl. 18, fig. 7; pl. 19, figs. 7, 11–12). With the apparent development of a hypha, there is an accompanying formation of sexual cells. This process may be slow or rapid, depending on conditions. On glycerine agar it seemed to be the most rapid, these particular organs being produced in three to five days. The antheridial or male cell contains two or three nuclei as a rule (pl. 22, figs. 6–8), but cases of four have also been seen. The ascogonium or female cell usually contains three to four nuclei (figs. 9–11), but five (fig. 12) have also been noticed.

When two sexual cells are ready for copulation, the antheridium bends over to meet the ascogonium as seen in pl. 22, figs. 10–11. The two gametes may be on the same hypha or on separate hyphae. Both may be terminal (figs. 13–17), or both lateral (fig. 16), or one may be lateral and the other terminal (fig. 12), or there may even be variations of these. Nevertheless it is

quite apparent that the male cell goes to meet the female cell. With the approach of the copulation branches, there is an action which may be termed tropistic and which may be explained, if analogies are acceptable, by a hormone action or physical stimulus as is found in zoological specimens, which calls forth the production of a beak, the copulating tube, as has been found in the lower yeasts. These two beaks meet and fuse. In the meantime, one of the nuclei proceeds to the tip of the beak. There is probably no specific nucleus involved in this act, because as far as can be made out all the nuclei are the same morphologically, and any nucleus that happens to be nearest the beak becomes sensitized to the fertilization reaction. With the progression of the fertilization nucleus, there is an accompanying retrogression of the remaining nuclei. Whether these disintegrate or not has not been definitely determined. In several cases where fertilization had taken place, it was noticed that the antheridial cell and basal portion of the ascogonium merely existed very much like functionless stamens in a flowering plant, which in the course of time disintegrated or perhaps degenerated.

The next step in the cycle involves the fusion of the nuclei, or syngamy perhaps. The walls between the two tubes are dissolved or diffuse and the two nuclei copulate or fuse in the tube (pl. 22, figs. 13–16). This is rather contradictory to Dangeard's ('94, '94a, '94b, '97) observations that the two nuclei fused in the ascus, and Harper's ('96, '97, '99, '00), that in the higher Ascomycetes the fusion occurred in the archicarp after the entrance of the contents of the antheridium. The fusion nucleus is then transferred or migrates (whatever the process may be it is analogous to that by which the nuclei copulate) into the ascogonium which is now known as the archicarp (pl. 22, fig. 17). The fusion tube dissolves in some cases or breaks away in others, with the broken portion being either resorbed by the cells or degenerating. At any rate, the archicarp repairs its walls by the resorption of the cellular contents, and the large fusion nucleus is ready for division (fig. 18).

The nucleus divides by a process of amitosis as previously mentioned. Although difficult to interpret theoretically, it presents no clear-cut chromosomal formation. With the first

division, there is apparently the formation of a wall (pl. 22, fig. 19). The daughter nuclei go through a synchronous division (fig. 20) to form four nuclei. In several of the yeasts and in *E. Magnusii,* the process halts here and each nucleus develops into a spore, thus four spores. Here, however, the four nuclei undergo a synchronous division, the second for the ascus, and eight nuclei are produced, which number is a mean for the species of this genus. In other species there may be twelve or sixteen nuclei.

In the higher Ascomycetes the problem of ascus formation is rather confusing, and the reader is referred to the work of Atkinson ('15), Bagchee ('25), Blackman and Fraser ('05), Brooks ('10), Brown ('10, '11), Carruthers ('11), Guilliermond, Mangenot and Plantefol ('33), Faull ('05), Fraser and Brooks ('09), Fraser and Welsford ('08), Gaümann and Dodge ('28), Harper ('96, '97, '99, '00), and Maire ('04, '05), to obtain full information and various opinions on the subject.

After the formation of the nuclei and the abjunction of the future ascus (8–14 μ in diameter) from the basal portion of the ascogonium, now a basal cell as seen in pl. 22, figs. 21–22, the development of the spores begins. Associated with this phenomenon are the secretion products which, as has been pointed out previously by Guilliermond, nourish the spores and produce the spore wall.

It should be pointed out here that, in addition to this heterogamous form of copulation, isogamy and finally parthenogenesis may also be present. The latter is quite apparent and has been found time and time again. The process may begin by the jutting out of what is apparently a conidium. This in turn develops and a nucleus becomes visible. The nucleus divides as noted in the above reaction and an ascus with eight ascospores forms (pl. 23, figs. 1–9). Also a terminal cell often produces a pyriform ascus parthenogenetically as seen in fig. 11. In all cases, the spores serve the same function and are equally as capable of producing new hyphae. The sporogenous plasma of the ascus, part of the cytoplasm, contributes greatly to the formation of the mature spore.

The life cycle of *E. capsulatus* on an artificial substrate might be graphically illustrated as in diagram 1.

Cellular contents.—The remainder of the ascus constitutes the epiplasm which is made up of reserve products in the form of lipoids, glycogen, the metachromatic granules of Guilliermond or nuclear decomposition products as volutin, oil globules, and nucleic acid substances and probably other protein derivatives and carbohydrates. All of these materials have been shown to be utilized by the spores in their growth. Several authors also present evidence that during the maturation process of the spores,

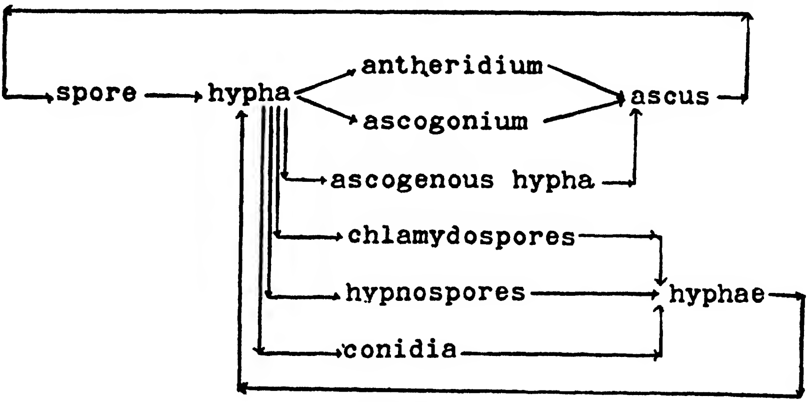


Diagram 1.

the substances constituting the epiplasm are broken down, a part being absorbed and clearly demonstrable in the granular contents at maturity, and a part reserved for their germination.

Volutin.—The cellular contents will be considered in the order studied. The first is what has been variously called "Neisser's granules" found by Neisser in bacteria; "sporogenous grains" found by Ernst; "metachromatic corpuscles" of Babès, who found them in the diphtheria bacillus and so named them because of their metachromatic action; "red grains" of Bütschli, so named because they took on a red coloration with many of the stains; and finally, one of the most common of all, volutin, as named by Meyer.

In the fresh state these granules stain blue with methylene blue (pl. 23, figs. 16–18), and when fixed their color is red to violet. They are small at first, and then enlarge to assume various forms and sizes. They may have a heavy staining outer portion and

a paler center, probably due to their refractive powers. They are seen quite often in vacuoles as represented here and assume fantastic features. They appear in the cell along the reticulated network, at the nodes, and stain heavily there. Volutin is very common in the younger cells, but not so abundant in the older hyphae. The substance may also be stained *in vivo* with neutral red. Wager and Peniston ('10) found Gram's aniline violet to be a useful stain for volutin.

Zikes ('22), studying the nature of volutin and of the physiological factors concerned in its production, found that it is present in moderately large amounts in nearly all fungi. Peptone when added to the culture media stimulated its production while ammonium sulphate and asparagin were not so favorable. Phosphorus was found to be essential for its formation, and glucose and fructose were more favorable than the carbohydrates of higher molecular weight. He concluded that volutin is an albuminous substance similar to the nucleo protein, as it contains both phosphoric acid and nuclein.

The general opinion seems to be that volutin is a nucleic acid substance with an unknown base, probably organic in nature, that it exists as a colloid, and that, due to fixatives, it is precipitated in the vacuoles. It is supposedly a secretion from the nucleus and is used in nourishing the spores.

Glycogen.—Another substance which supposedly acts as a reserve material and is used up for the maturation of the spores in the ascus is glycogen. This theory has been substantiated by the fact that glycogen is used up in the cell, particularly in maturing asci, as evidenced by its slow disappearance. Kohl ('07) considered glycogen not as a reserve material, but as a regulator for the intake of sugar in the cell, in that it is the substance formed, not being able to diffuse out from the membrane. He found it to be lacking in spores, and since reserve materials should be present, he presented this as evidence that glycogen is not a reserve material. Guilliermond, however, claims to have demonstrated that glycogen is absorbed by the ascospores at the time it is found to disappear from the epiplasm.

Glycogen is found in the organism practically from the beginning of growth, first as small droplets perhaps, but later in

fairly large masses (pl. 23, figs. 19–30). It has been estimated as constituting 32 per cent of the dry weight of yeast cells. It is associated with the nutritive condition by some workers and found to be almost entirely used up or greatly accumulated according to the condition of nutrition and growth. According to some workers it appears somewhat in the form of a vacuole and it has thus been called a glycogen vacuole. It is not a true vacuole, but perhaps a colloidal substance, as volutin is considered to be, for it takes a stain much as the latter does. It may be stained *in vivo* with neutral red (figs. 26, 29–30), in which case it is not so clear, at least in *E. capsulatus*, as with a saturated solution of iodine potassium iodide, a modification of Gram's stain (figs. 19–25, 27–28).

This substance is a glucoside, a polysaccharide which, like starch, is made up of n molecules of glucose to have the formula $(C_6H_{10}O_5)_n$. It is often compared with starch since it requires phosphorus for its formation. In fact, it has often been referred to as an amylopectin, which makes up the superficial part of the starch grain. By hydrolysis, glycogen is broken down to dextrin, then maltose, and finally glucose. On heating a saturated solution of glycogen stained with iodine potassium iodide it becomes pale but regains its intensity on cooling. It is insoluble in alcohol.

Vacuoles.—The question of vacuoles in fungi has been given considerable attention in the past, and the author does not intend to enter into a discussion of them. However, in view of the many theories advanced as to their character and presence, mention of them in *E. capsulatus* would not be out of place. They are easily demonstrable with many dyes and present varied characteristics. With methylene blue, they are easily made visible (pl. 23, figs. 15, 17–18). They appear to be formed by the reticulum and to take the stain. They may be demonstrated fairly clearly with iodine green (fig. 14), and the standard dye seems to be neutral red, in which case small crystalloid bodies, often described as "dancing bodies," probably Brownian movement, may be seen (figs. 26, 28). Haematoxylin also brings them out distinctly by staining the surrounding network (figs. 1–2). What the function of vacuoles may be is difficult

to understand. It is known that they are colloidal solutions of cytoplasmic materials, formed by the absorption of water, that they may enlarge or disappear in a cell, and Guilliermond, Mangenot and Plantefol, say this of them, "Les vacuoles représentent la phase aqueuse du cytoplasme et jouent certainement le rôle important en réglant la teneur en eau de la cellule."

Chondriosomes.—The bodies designated as mitochondria or chondriosomes have been demonstrated in animal and plant tissue. What their particular function may be is not definitely known. In plants they have been associated with the elaboration of chlorophyll and starch through the agency of the chloroplasts. In animals they are supposedly associated with the elaboration of secretions, but no definite evidence has been produced along this line. They have been demonstrated in a number of lower plants, lower fungi and the higher Ascomycetes, and in fact, in practically all of the groups, as well as in animal cells. For further information the reader is referred to Guilliermond ('11b), who has traced the development of these particular bodies in many organisms.

Chondriosomes (Cowdry, '17) have been shown in both animal and plant cells to be almost completely soluble in alcohol, ether, chloroform, and dilute acetic acid (organic solvents) and to be insoluble by chromization and treatment with formalin, at least in most cases. In the animal cell they do not stain with Sudan III or IV and are sometimes blackened with osmic acid. In plants, the whole cell blackens with osmic acid so readily that it is impossible to know just to what extent the chondriosomes themselves are affected.

In studying *E. capsulatus,* the author made use of the knowledge that chondriosomes are very clearly demonstrated by the addition of iodine potassium iodide to a preparation of an organism. They are fairly evident as lightly staining rod-like and short bodies (light yellow with iodine), but one must pay particular attention to distinguish them (pl. 23, figs. 19–25). There are short and rod-like bodies in the terminal hypnospores and some long forms too, as well as small point-like reflective granules. The rods are longer in the hyphae (figs. 23–24). Chondriosomes are scattered throughout the asci as fine, small, rounded bodies.

It can thus be stated that by the iodine potassium iodide method, bodies comparable to those described as chondriosomes for other fungi are demonstrable.

Fat, lipoidal substances.—In addition to the many substances mentioned, there are also fats, lipoidal substances, and other materials called reserve materials, secretion products, and also excretion products. These materials are found in varying amounts in many of the specialized portions of the organism, being abundant in the asci and chlamydospores and in very small amounts in young hyphae and younger elements. They can be demonstrated comparatively easily in spores and in yeasts particularly. The nature of many of these substances has not been determined as yet, but it is generally known that fatty acids, glycerides and sterides, glycerol, phospholipides and phosphoaminolipides (complex lipides) may be present in certain amounts.

Several agents were used for the study of these materials, each giving some degree of difference in distinguishing them. A 2 per cent osmic acid solution which reduces fats and gives them a black coloration was the first tried. When applied to the living mycelium, the fats and lipoidal substances appear as small refractile bodies or droplets but in some cases they are very much larger (pl. 23, figs. 31–36). They are seen rather abundantly in old hyphae (fig. 36) and in very small amounts in young hyphal tips (fig. 35). With platinic chloride (5 per cent solution) they appear as blackened granules much the same as with osmic acid (figs. 37–38). Iodine potassium iodide as applied for glycogen and chondriosomes shows lipoidal substances, as oil droplets, equally as well. These are very small, highly refractile, and hyaline, and to be seen require careful focusing and adjustment of the microscope (figs. 19–20, 23–25). Neutral red has also been used, but not much attention was paid to the reaction outside of what has already been mentioned with regard to glycogen and the vacuoles. Iodine green also has an affinity for lipoidal substances, but not enough attention was given to it to prove its value here.

Cultural Characteristics

In studying the cultural characteristics of *E. capsulatus*, all the media available at the time were utilized. This was considered essential, inasmuch as it has become an unfortunate custom with some mycologists to name as new species organisms which show a physiological variation on a different medium. Since the fungus had shown on previous occasions of culturing that it favored protein substrates, a variety of protein materials was chosen. In addition, regular routine media were used, some with much carbohydrate and some with very little. For some years the question of hydrogen-ion concentration has become an important factor in work of this sort, and media with a wide range of pH were chosen within which the possibilities of growth had at one time or another been emphasized. All cultures were grown at a temperature of approximately 25° C.

The following media arranged in the order of their decreasing hydrogen-ion concentrations were used:

Raulin's Solution Agar (Raulin's solution plus 1.5 per cent agar, pH 4.1).—(pl. 18, fig. 7; pl. 19, figs. 8, 10–12). Growth poor, being present only around inoculum after 18 days and having a diameter of only 0.7 cm. and 1.6 cm. at end of 30 days. Color white. Hyphae grown heaped up from center in a loose fashion. Microscopically, abundance of conidia, pedicelled or sessile, 5 μ in diameter; endo-chlamydospores 5–7 μ in diameter; terminal hypnospores 4–6 x 8–11 μ; hyphae 2 μ in diameter; racquet mycelium in small amount, not very noticeable; asci 9–10 μ in diameter.

Richards' Solution Agar (Richards' solution plus 1.5 per cent agar, pH 4.3).—(pl. 19, figs. 5–7, 9). Growth slow, very sparse and cottony, with long and narrow hyphae 2 μ in diameter, projecting loosely and irregularly from the edge of the colony which attained a diameter of approximately 1.8 cm. at end of 18 days and 3.5 cm. at end of 30 days. Round conidia very numerous, approximately 4 μ in diameter; pyriform conidia sessile or on short stalks, several, 3½ x 7 μ in diameter; round, thick-walled chlamydospores on short pedicels, 5 μ in diameter; asci few, 7–9 μ in diameter; endo-chlamydospores approximately 6 μ in diameter.

Czapek's Agar (pH 4.4).—Growth of very loose and sparse mycelium which spreads over the surface of the agar with thin hyphae. Macroscopically the culture is barely visible except by reflected light. Colony approximately 3 cm. in diameter at end of 18 days and 6.7 cm. at end of 30 days. Color white. Hyphae 2½–3½ μ in diameter; racquet mycelium present, 6–7 μ in diameter at swollen portion and 2½–3 μ at thin portion; terminal hypnospores 7 x 12 μ approximately; conidia many, 5 μ in diameter; round chlamydospores 6 μ in diameter; lateral chlamydospores 6 x 11 μ; asci several, 10 μ in diameter.

Wort Agar (Product of Digestive Ferments Co., pH 4.6).—(pl. 18, figs. 6, 8–10, 15). Growth at first slow, none on several of the cultures, in general thin and loose. One of the cultures showed good growth, attaining a diameter of 3.2 cm. at end of 18 days and 5 cm. at end of 30 days. This was unusual and may be ascribed to too great an inoculation and to a dissemination of spores as a result of shaking. Color white. Terminal hypnospores many, 7 x 12 μ; hyphae 3½–4 μ in diameter; chlamydospores 6½–7 μ in diameter; racquet mycelium abundant; conidia numerous, 5–6 μ in diameter; asci 10–11 μ in diameter.

Malt Extract Agar (pH 5.1).—(pl. 18, figs. 1–3). Growth not so abundant, colony 1.6 cm. at end of 30 days. Color slightly brown, due to the malt extract. Mycelium of numerous swelled cells; hyphae 3–4 μ in diameter; terminal hypnospores 6 x 16 μ; hyphal swellings or chlamydospores 9 x 12 μ; numerous conidia, pyriform and round, the round being approximately 5 μ in diameter; asci very few, 10 μ in diameter.

Malt Extract Broth (The above minus the agar).—Very little growth at end of 30 days. Characteristics same as above.

Maltose Agar (pH 5.4).—Growth slow. Colony coremium-like, with a diameter of 1.5 cm. at end of 30 days. Hyphae short, 3–4 μ in diameter. Many round chlamydospores 5 μ in diameter; terminal hypnospores numerous, 4–6 x 9–11 μ; asci few, 8–10 μ in diameter.

Sabouraud's Broth (Sabouraud's dextrose agar minus the agar, pH 5.5).—(pl. 21, fig. 21). Culture consists of submerged colonies of mycelium varying from ½ to 3 cm. in diameter at end of 18 days, with a great mass at the end of 30 days as a result of the

coalescence of all the colonies. The large flakes are grey in color when moist, but with white mycelium on the surface, fairly dry. Submerged hyphae 2½ μ in diameter with none or very few morphological characteristics. Aerial or dry mycelium, however, similar to that on the agar culture of the same medium.

Sabouraud's Agar (pH 5.6).—(pl. 16, figs. 12–14; pl. 19, figs. 13–25; pl. 21, figs. 14, 18, 28). Thick cream-colored growth with a diameter of 4.5 cm. in 18 days and 7 cm. in 30 days. Hyphae 2–3½ μ in diameter, in needle-like projections from the surface of the mycelium which appears very cottony. Color white. Older cultures show a felt-like matting with a tendency towards ridge formation, a condition found to a certain extent in *Microsporon Audouini* Ota and Langeron. Racquet mycelium present with swollen portions 4–6 μ and narrow section 3 μ; many lateral chlamydospores, 5–7 x 10–12 μ; terminal hypnospores 5 x 11 μ; and many conidia, pyriform or round, approximately 5 μ in diameter; numerous asci, 10–12 μ in diameter, with 8 ascospores 2–2½ μ in diameter.

Oat-Meal Agar (Decoction of oat-meal plus dextrose and agar, pH 5.9).—Growth diffuse and slow, 5 cm. in diameter after 30 days. Culture loose and cottony. Hyphae 2–2½ μ in diameter; numerous thick-walled, round resting cells or chlamydospores, 4–6 μ in diameter; terminal hypnospores 4 x 7 μ; conidia numerous, 4 μ in diameter; asci several, approximately 8 μ in diameter.

Corn-Meal Agar (Product of Digestive Ferments Co., pH 6.0).—(pl. 16, figs. 8–9; pl. 21, fig. 24). Growth very loose and thin, with the hyphae projecting from the colony, appearing as threads of silk. Colony barely visible except from a lateral view. Hyphae long and thin, 2–2½ μ in diameter, with colony attaining a diameter of 5 cm. at end of 21 days and 6 cm. at end of 30 days; chlamydospores 6 μ in diameter; conidia many, 4½–5 μ in diameter; terminal hypnospores 5 x 7 μ; racquet mycelium present but reduced in size, 3–4 μ at swollen portion; asci several, 7–8 μ in diameter.

Potato-Dextrose Agar (Decoction of potatoes plus dextrose and agar, pH 6.2).—(pl. 21, fig. 22). Colony 3.6 cm. in diameter at end of 30 days, edge smooth and round, no striations or other cultural changes as ridges. Growth thick and cottony at in-

oculum, with a thin periphery about 2–3 mm. in width. Color white. Hyphae 2–2½ μ in diameter and long; conidia numerous, 5 μ in diameter; terminal hypnospores few, 4 x 7 μ; chlamydospores rare; asci few, 8–10 μ in diameter.

Two Per Cent Aqueous Bacto-Peptone (*Hanging-drop culture, pH 6.2*).—(pl. 21, figs. 1–8, 25, 32). Mass of thick-walled hyphae ramifying and branching, 2–2½ μ in diameter; racquet mycelium not evident; numerous chlamydospores, 4 μ in diameter; asci 4–6 μ in diameter; few terminal hypnospores, 3.5–5 x 6–7 μ.

Two Per Cent Aqueous Bacto-Peptone Plus Five Per Cent Meat Extract (*Hanging-drop culture, pH 6.2*).—(pl. 19, figs. 1–4; pl. 21, figs. 9–13). Growth profuse, covering the drop in 4 days. Hyphae 2–2½ μ in diameter, with an abundance of racquet mycelium intertwining and branching; thick-walled cells, chlamydospores in abundance, as well as asci 10 μ in diameter.

Two Per Cent Proteose Peptone Plus Six Per Cent Glycerine (*Hanging-drop culture, pH 6.2*).—(pl. 16, fig. 7; pl. 17; pl. 21, figs. 15, 30). Growth similar to that on bacto-peptone broth, but with an abundance of chlamydospores and racquet mycelium.

Lactose Broth (*Product of Digestive Ferments Co., pH 6.8*).—(pl. 21, fig. 17). Growth of submerged large flakes of colorless mycelium measuring approximately 2 cm. in diameter at end of 18 days. These later coalesced or intertwined into a mat which grew up the sides of the flask to form a white mycelium. Submerged hyphae approximately 3 μ in diameter, branching, intertwining, with cross-walls. Swellings, chlamydospores, terminal hypnospores, and asci few in number and reduced in size as compared with those on agar. The aerial mycelium above the surface of the broth showed an increased number of characteristics which simulated those found on the agar.

Lactose Agar (*The above medium plus 1.5 per cent agar, pH, 6.8*).—(pl. 18, fig. 11; pl. 19, fig. 20). Growth rapid, thick and cottony, colony attaining a diameter of 3.6 cm. at end of 18 days and 6.2 cm. at end of 30 days. Culture showed 4 ridges radiating from a thick inoculum to a thick cottony circular periphery surrounded by a thin growing rim of hyphae. Culture similar to that on nutrient agar, macroscopically. Hyphae 2½–3½ μ in diameter; conidia many, 4½–5 μ in diameter; terminal hypno-

spores 4 x 7½ μ; racquet mycelium present in abundance; many chlamydospores, varying from 6 μ in diameter (round) to 5 x 8 μ (pyriform); asci many, 8–9 μ in diameter.

Nutrient Agar (Product of Digestive Ferments Co., pH 6.8).—(pl. 21, fig. 19). Growth good, with the colony having a diameter of 3.5 cm. at the end of 20 days and 7.0 cm. after 30 days. Growth loose and cottony, showing concentric circles, evidently due to a periodical formation of asci and the liberation of the spores which germinated. Single spore colonies 2 cm. in diameter after 15 days. Colony flat with age, and white. Hyphae 2–3 μ in diameter; conidia many, sessile or pedicellate, 5 μ in diameter; chlamydospores several, 6 μ in diameter when intercalary, 5 x 7 μ when lateral, 6 x 11 μ when terminal (hypnospores); racquet mycelium present, 5 x 3 μ.

Nutrient Broth (Meat extract, pH 6.8).—(pl. 21, fig. 31). Culture similar to that on lactose broth.

Uschinsky's Protein-free Medium (pH 6.8).—No growth.

Beef Extract Agar (Liebig's extract of beef, pH 7.0).—(pl. 16, fig. 15). Growth similar to that on lactose agar. Radiating ridges present.

Eosine-Methylene-Blue Agar (Product of Digestive Ferments Co., pH 7.0).—(pl. 21, fig. 27). Growth good, attaining a diameter of 5 cm. after 26 days. Color pink in younger portion of culture (periphery), darker pink to blue towards the inoculum, this being due to an absorption of the dyes by the mycelium. Growth ceased and colony became flat. Hyphae in growing culture 2–3½ μ in diameter, with morphological characteristics similar to those on Sabouraud's agar.

Glycerine Agar (Nutrient agar plus 6 per cent glycerine, pH 7.1).—(pl. 16, figs. 1–3, 11; pl. 21, figs. 16, 23, 26, 29). The colony on this medium grew as a cerebriform, very thick, creamy culture, having a diameter of 6 cm. at the end of 30 days. Medium best for study of organism because of its nutrient constituents, presence of abundant protein and carbohydrate, and an abundance of endo-chlamydospores, 5½–6 x 11 μ; intercalary chlamydospores 4–5 x 5–7 μ; terminal hypnospores 4–6 x 9–12 μ; hyphae 2½–4 μ in diameter; round chlamydospores, either terminal or lateral, approximately 6 μ in diameter; racquet mycelium abundant; asci numerous, 10–14 μ in diameter.

Blood Agar (pH 7.2).—(pl. 16, figs. 4–6). Growth similar to that on nutrient agar.

Chocolate Agar (Blood agar heated to about 75° C. until the blood became chocolate colored, pH 7.2).—Growth similar to the above.

Serum Agar (Beef extract agar plus 10 per cent dehydrated blood serum, pH 7.2).—(pl. 18, figs. 4–5, 12–14, 16). Growth moist, showing a diameter of 1.4 cm. at end of 10 days and 3.5 cm. at end of 30 days. Colony flat and even. Many yeast-like cells seen; hyphae few and several large cells. Center of colony cerebriform. With age the culture shows prickly forms of mycelium (dry) which covers the greater part of the culture. This evidently is a reversion to the yeast form, to a certain extent.

Calcium Carbonate Agar (pH 7.4).—(pl. 16, fig. 10). Growth slow at first, then rapid, with a diameter of 7.4 cm. in 30 days. Colony compact, with a cerebriform central portion, and a loose, cottony outer zone. Color white. Hyphae 2–2½ μ in diameter; conidia numerous, 4½–5 μ in diameter, being spread throughout the entire culture, mostly round, several pyriform on short peduncles, others sessile; round chlamydospores many, 6 μ in diameter, and terminal hypnospores 4–5 x 7–9 μ; racquet mycelium not very evident; asci many, approximately 8 μ in diameter.

Endo's Agar (Product of Digestive Ferments Co., pH 7.5).—Growth slow, not quite so rapid as that on eosine-methylene-blue agar. Colony white at first, then, due to an absorption of the dye from the agar, pink to red, growing in coremium-like masses of straight hyphae with very few or no conidia. Hyphae short and thick-walled, 3½–4 μ in diameter. Few conidia in culture, 6 μ in diameter; hypnospores very few, as well as round chlamydospores; asci several, 10 μ in diameter.

Litmus Milk.—Milk was heated in a flask for fifteen minutes in steam, then set away over night in the ice-chest to allow the cream to rise. The cream was then siphoned off and the milk diluted in the ratio of 1 part milk to 4 parts water, with enough litmus as an indicator. Tubes of this solution were sterilized by steam, then inoculated, and kept at 25° C. No growth resulted after 20 days.

Reaction to Temperature.—In studying an organism, it is necessary, especially if quantitative results are desired, to determine conditions under which optimum growth can be obtained. One factor which enters into such considerations with fungi is temperature. It is known that various organisms grow best at certain temperatures and when placed in other conditions, growth will either be inhibited or retarded. With this point in mind, it was decided to grow a number of cultures on the same medium and same pH at various temperatures. As a medium, Liebig's beef extract agar at pH 7.2, which on previous occasions had shown a qualitatively and quantitatively good growth, was employed.

E. capsulatus, when first isolated from the lesions in its yeast-like form, showed very good growth at body temperature, 37.5° C. After having been kept in culture in its filamentous form for about two years, the optimum temperature was shown to be approximately 30° C. Continued growth on an artificial medium again reduced its optimum temperature, to approximately 25° C., as may be seen in table I, or figs. 1–2.

Several cultures in petri dishes were grown at the various temperatures indicated in table I. The experiment was performed at three different times, and due to the fact that daily measurements required handling of the cultures, several of the plates showed contamination. A procedure such as this usually brings in some foreign spores, especially in a large laboratory where many open cultures may be found.

The plates of the first two temperatures, −0.7° C. and 8.0° C., were kept in a Kelvinator, the former in the freezing unit where a fairly constant temperature was maintained, and the latter in a compartment some distance from the cooling device. The third set of plates, 16.0° C., was kept in a glass jar with running water around it. The temperature fluctuated somewhat, but not enough to affect the experimental data seriously. The plates of the other temperatures were kept in regulated incubators.

All the plates were inoculated with a loopful of a suspension mashed up with a sterile needle and contained 5 cc. of a beef extract broth solution of pH 7.2. In some cases the inoculum proved greater than others.

TABLE I
MEAN DIAMETERS IN CENTIMETERS OF COLONIES GROWN AT VARIOUS TEMPERATURES

Beef extract agar (Liebig's extract of beef) pH 7.2

Days after inoculation	Temperature in degrees Centigrade							
	−0.7	8.0	16.0	21.0	25.0	31.0	37.0	40.0
1	0.4	0.3	0.3	0.3	0.4	0.4	0.4	0.3
2	0*	0	0.3	0.4	0.5	0.4	0.4	0
3	0	0	0.3	0.4	0.8	0.7	0.6	0
4	0	0	0.3	0.5	1.0	0.9	0.7	0
5	0	0	0.4	0.7	1.3	1.1	0.9	0
6	0	0	0.6	0.9	1.6	1.3	1.1	0
7	0	0	0.8	1.1	2.0	1.6	1.3	0
8	0	0	0.9	1.4	2.2	1.8	1.4	0
9	0	0	1.1	1.7	2.5	2.0	1.5	0
10	0	0	1.3	1.9	2.7	2.2	1.5	0
11	0	0	1.4	2.2	3.0	2.5	0	0
12	0	0	1.6	2.4	3.3	2.7	0	0
13	0	0	1.8	2.6	3.5	2.9	0	0
14	0	0	2.0	2.8	3.8	3.2	0	0
15	0	0	2.1	3.0	4.1	3.4	0	0
16	0	0	2.3	3.2	4.4	3.6	0	0
17	0	0	2.5	3.4	4.7	3.9	0	0
18	0	0	2.7	3.7	5.0	4.1	0	0
19	0	0	2.9	4.0	5.2	4.4	0	0
20	0	0	3.1	4.2	5.5	4.7	0	0
21	0	0.3	3.3	4.5	5.7	4.9	0	0
22	0	0.3	3.5	4.8	5.9	5.1	0	0
23	0	0.4	3 6	5.0	6.2	5.3	0	0
24	0	0 5	3.7	5.2	6.5	5.5	0	0
25	0	0.5	3.8	5.5	6.8	5.7	0	0
26	0	0.6	3.9	5.6	7.1	5.8	0	0
27	0	0.8	3.9	5.7	7.4	5.9	0	0
28	0	0.9	3.9	6.0	7.7	6.0	0	0
29	0	1.0	3.9	6.2	7.9	6.1	0	0
30	0	1.1	3.9	6.5	8.2	6.2	0	0
31	0	1.2	3.9	6.7	8.3	6 2	0	0

*0 indicates no growth

Readings were made daily for 31 days, at approximately the same hour. The mean results of a representative series are given in table I. Three plates were kept in the final table as representive of the experiment although several additional plates were used.

An analysis of the results of this experiment shows that no growth takes place at —0.7° C. and at 40.0° C. At 8.0° C. growth does not begin until the twenty-third day and then proceeds slowly, with a maximum diameter of 1.2 cm. which would represent a total growth of 0.9 cm. At 16.0° C. the culture does not show growth until the fourth day, and grows slowly but faster than that at 8.0° C., to show a final diameter of 3.9 cm. or 3.6 cm. actual growth. At 21.0° C. there is a final diameter of 6.7 cm., with a total growth of 6.4 cm. At 25.0° C. the diameter of the colony reached an optimum of 8.3 cm. and an actual growth of 7.9 cm., and at 31.0° C. the diameter of the colony was 6.2 cm. with a total growth of 5.8 cm. The culture at 37.0° C. grew fairly well for the first ten days but after that no further growth. Transfers from these last plates to fresh medium produced no growth, hence it could be concluded that the heat finally killed the organism.

In fig. 1, the diameter of the colony in cm. was plotted against the time in days to obtain the rate of growth for each temperature. It may be seen here how the growth was affected. At optimum temperature, after the initial lag period of 1–2 days, growth proceeded in practically a straight line. With a deviation from the optimum temperature there is accordingly a decrease in the growth rate which corresponds to the temperature affecting it. At 16.0° C. we find a regular sigmoid curve which represents an initial lag period followed by a period of increased activity and finally a return to the lag period.

When the maxima points of total growth are plotted, fig. 2 (diameter of colony against temperature), we have the relationship of the total growth to the various temperatures outlined.

These results seem to indicate that the optimum growth for this organism has changed from approximately 37.5° C. in its parasitic condition to 25° C. in a saprophytic condition. This latter fact will be demonstrated in the animal inoculation experiments. It also shows that the longer an organism is kept in culture the greater will be its change in physiological phenomena to an optimum point for its changed environment.

Hydrogen-Ion Concentration.—The problem of hydrogen-ion concentration has been of interest for several years and its

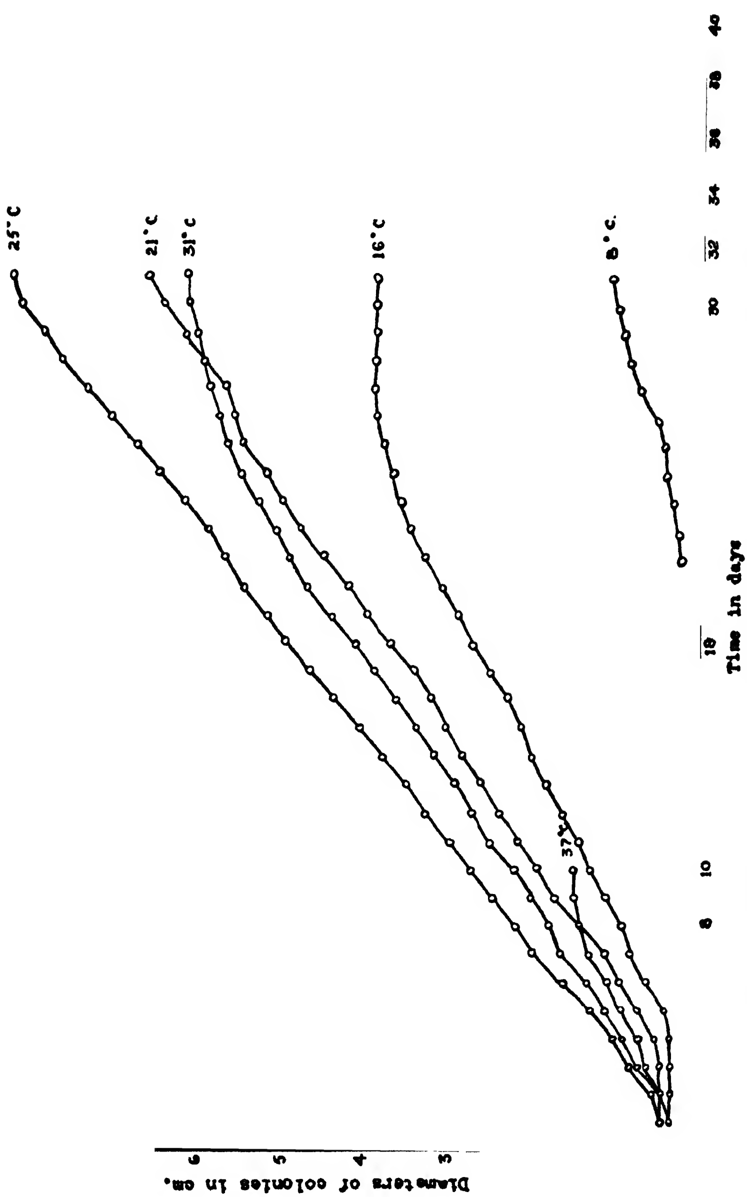


Fig. Rate of ious temperatures with same pH.

consequences especially emphasized by von Mallinckrodt-Haupt ('32). It has been demonstrated that the change of pH in a medium plays an important part in the cultural characteristics

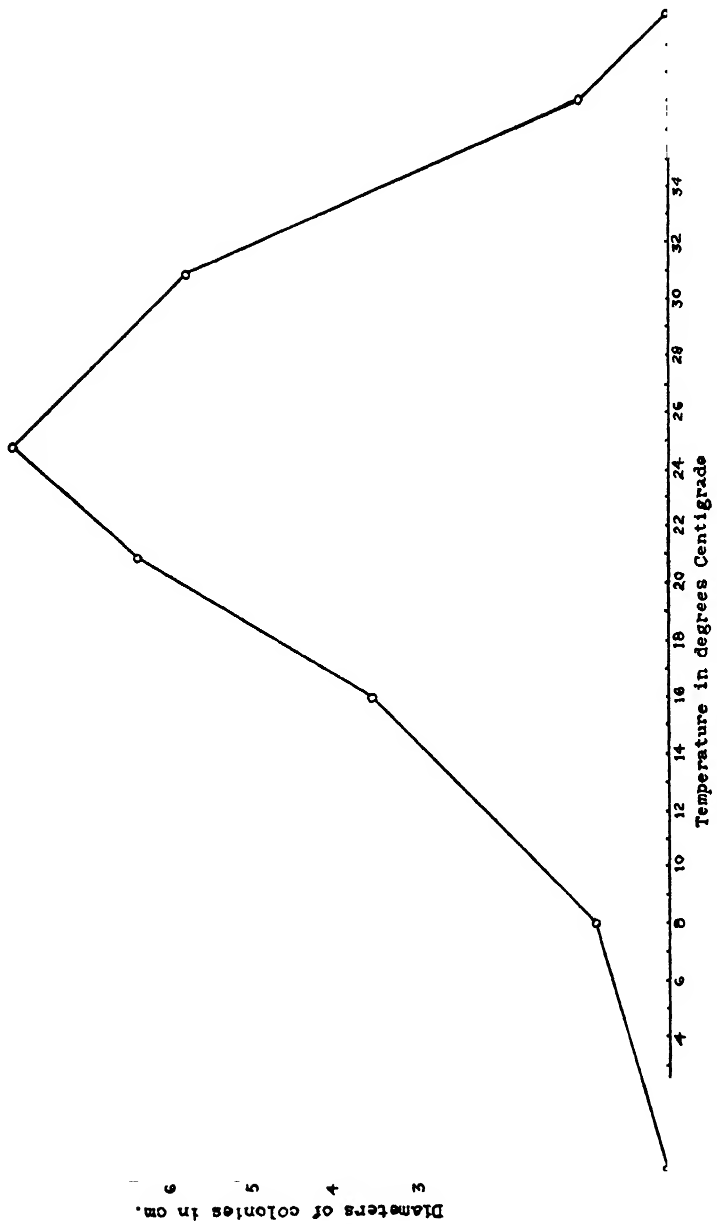


Fig. 2. Maximum growth at various temperatures on beef extract agar with same pH.

of the fungi grown. These changes may be brought about in their nutrient medium through the formation of acids which are

present in large amounts, by the breakdown of the sugar molecule in its utilization by the organism, by the decomposition of the proteins or the products, and by the cracking of fats or lipoids as a result of growth. As is perhaps fairly evident in the case of the carbohydrate reactions to be explained later, we have the formation of alkaline bases which are observed in the course of the utilization of the proteins.

From a study of the cultural characteristics mentioned previously and from further observations, a decided difference in growth on acid and alkaline media may be pointed out. In strongly acid media there is abundant budding and a formation of numerous conidia, and on strongly alkaline media a tendency towards shorter, thicker cells and a yeast-like cell formation. On the other hand, on weakly acid or alkaline media there is a favorable condition established for mycelial and hyphal formation.

The effect of alkalinity and acidity on the development of fungi was noticed for a number of years. Marantonio ('93) found that a more acid medium favored a greater quantity of mycelium. These observations were confirmed by Concetti ('00) and were extended to include a large number of media. Strains of an organism isolated from cases of thrush were used. Fineman ('21), working with *Monilia albicans* apparently, found that mycelium grew better in media under low surface tension and oxygen tension while the yeast form of the organism predominated on solid media, simple carbohydrates, and a high pH. Milochevitch ('29) found that varying the hydrogen-ion concentrations of media had no effect on the same sort of a fungus. Talice ('30) found the best development of hyphae on dilute potato decoction, the hydrogen-ion concentration being perhaps fairly high.

Several workers have pointed out that fungi possess a certain buffer action, that is, they have the ability to regulate their growth according to the reaction of the medium, and it is found to exist only under external changes. This means, then, that acid media become less acid during the course of growth and alkaline media become less alkaline.

What has been found to be true for the effect of various temperatures on the growth of *E. capsulatus* may also be said to hold with regard to hydrogen-ion concentration. For testing this,

beef extract agar made up with Liebig's extract of beef but adjusted to the various pH's shown in table II, was inoculated as described previously. The same procedure was carried out as in the above experiments, namely, daily diameter measurements and occasional microscopic examinations. Here, as before,

TABLE II

MEAN DIAMETERS IN CENTIMETERS OF COLONIES GROWN IN VARIOUS HYDROGEN-ION CONCENTRATIONS, AT A TEMPERATURE OF 26° C.

Beef extract agar (Liebig's extract of beef)

Days after inoculation	pH values												
	2.1	3.3	4.2	5.2	5.5	6.1	6.4	7.0	7.4	7.7	8.2	9.3	10.4
1	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.3	0.4	0.3	0.4	0.4
2	0*	0	0.3	0.3	0.3	0.3	0.3	0.4	0.3	0.4	0.3	0.4	0
3	0	0	0.3	0.4	0.4	0.4	0.4	0.6	0.5	0.6	0.4	0.4	0
4	0	0	0.3	0.5	0.5	0.6	0.7	0.9	0.8	0.9	0.6	0.5	0
5	0	0	0.3	0.7	0.8	0.9	0.9	1.2	1.2	1.2	0.8	0.7	0
6	0	0	0.3	1.0	1.1	1.2	1.2	1.4	1.6	1.6	1.1	0.9	0
7	0	0	0.3	1.3	1.3	1.5	1.5	1.7	2.0	1.9	1.4	1.1	0
8	0	0	0.3	1.4	1.6	1.8	1.9	2.1	2.3	2.2	1.8	1.3	0
9	0	0	0.3	1.7	1.9	2.1	2.2	2.3	2.7	2.5	2.0	1.5	0
10	0	0	0.4	2.0	2.2	2.4	2.4	2.6	3.0	2.8	2.4	1.8	0
11	0	0	0.5	2.3	2.5	2.7	2.7	2.9	3.3	3.2	2.7	2.0	0
12	0	0	0.6	2.6	2.8	3.0	3.1	3.2	3.7	3.5	2.9	2.2	0
13	0	0	0.8	2.9	3.1	3.3	3.4	3.6	4.0	3.8	3.2	2.3	0
14	0	0	1.0	3.1	3.4	3.5	3.7	3.8	4.3	4.1	3.5	2.4	0
15	0	0	1.1	3.3	3.6	3.8	4.0	4.1	4.6	4.4	3.8	2.4	0
16	0	0	1.3	3.7	3.9	4.2	4.2	4.5	4.9	4.7	4.1	0	0
17	0	0.4	1.6	4.0	4.3	4.5	4.6	4.8	5.3	5.0	4.4	0	0
18	0	0.6	1.8	4.3	4.5	4.8	5.0	5.2	5.6	5.4	4.7	0	0
19	0	0.8	2.1	4.6	4.8	5.1	5.3	5.5	5.9	5.7	5.1	0	0
20	0	0.9	2.3	4.9	5.1	5.4	5.6	5.9	6.3	6.0	5.4	0	0
21	0	0.9	2.5	5.1	5.3	5.7	6.0	6.2	6.6	6.4	5.6	0	0
22	0	0.9	2.7	5.3	5.5	6.0	6.3	6.5	6.9	6.8	5.9	0	0
23	0	0.9	2.8	5.4	5.6	6.2	6.5	6.8	7.2	7.1	6.2	0	0
24	0	1.0	3.0	5.7	5.9	6.4	6.7	7.0	7.4	7.2	6.4	0	0
25	0	1.0	3.1	5.8	6.1	6.6	6.9	7.2	7.6	7.4	6.5	0	0
26	0	0	3.2	5.8	6.3	6.8	7.0	7.4	7.8	7.6	6.7	0	0
27	0	0	0	5.9	6.4	6.9	7.1	7.5	8.0	7.8	6.9	0	0
28	0	0	0	6.1	6.5	7.0	7.2	7.6	8.2	8.0	7.0	0	0
29	0	0	0	6.2	6.6	7.1	7.3	7.7	8.3	8.1	7.1	0	0
30	0	0	0	6.3	6.7	7.1	7.4	7.7	8.4	8.2	7.1	0	0

*0 indicates no growth

contaminations were present, so that only three plate measurements were incorporated in the table. The mean results in table II represent a typical set of data in this work.

An analysis of the data shows that no growth took place at a pH of 2.1 and 10.4. At pH 3.3, growth was not evident until the seventeenth day, when the diameter was 0.4. The total growth was 0.7 cm. on the twenty-fourth day, after which it stopped. A transfer of the culture to a medium of pH 7.2 gave normal good growth. With an increase in pH to 4.2, growth was at first slow, but the colony attained a diameter of 3.2 cm. on the twenty-sixth day and then growth stopped, showing a total increase of 2.9 cm. In like fashion, by subtracting the initial inoculum measurement from the final colony diameter, we find that at pH 5.2 total growth for thirty days was 6.0 cm.; for pH 5.5, 6.4 cm.; for pH 6.1, 6.8 cm.; for pH 6.4, 7.1 cm.; for pH 7.0, 7.3 cm.; for pH 7.4, we find the optimum pH with a total growth of 8.1 cm.; for pH 7.7, 7.8 cm.; for pH 8.2, 6.8 cm., which is the same as that for pH 6.1; for pH 9.3, total growth of 2 cm. was acquired on the fifteenth day, with the colony showing no additional growth.

By plotting the diameter of the colony against the time in days, fig. 3, we obtain the rate of growth for the optimum pH which shows, except for the initial lag and a final lag, the latter being due perhaps to external factors as slight drying and probable utilization of most of the nutrients, an almost straight line. This varies with the pH, showing a decreased growth rate from the optimum, with an increased lag and decreased period of activity.

By plotting the maxima points of growth or total growth for each pH against the pH values, we obtain a clear relationship of the growth at various hydrogen-ion concentrations, with the point of optimum growth forming a peak, as seen in fig. 4.

In addition, the pH of several of the media after growth was determined. No definitely accurate results were obtainable due to the dried-up condition of several of the media, but indications seemed to be that there was an increased pH where growth was best, with no change in the strongly alkaline and strongly acid. The results may be interpreted by considering the amount of growth as an index of the production of alkali due to the utilization and decomposition of the protein substances in the medium.

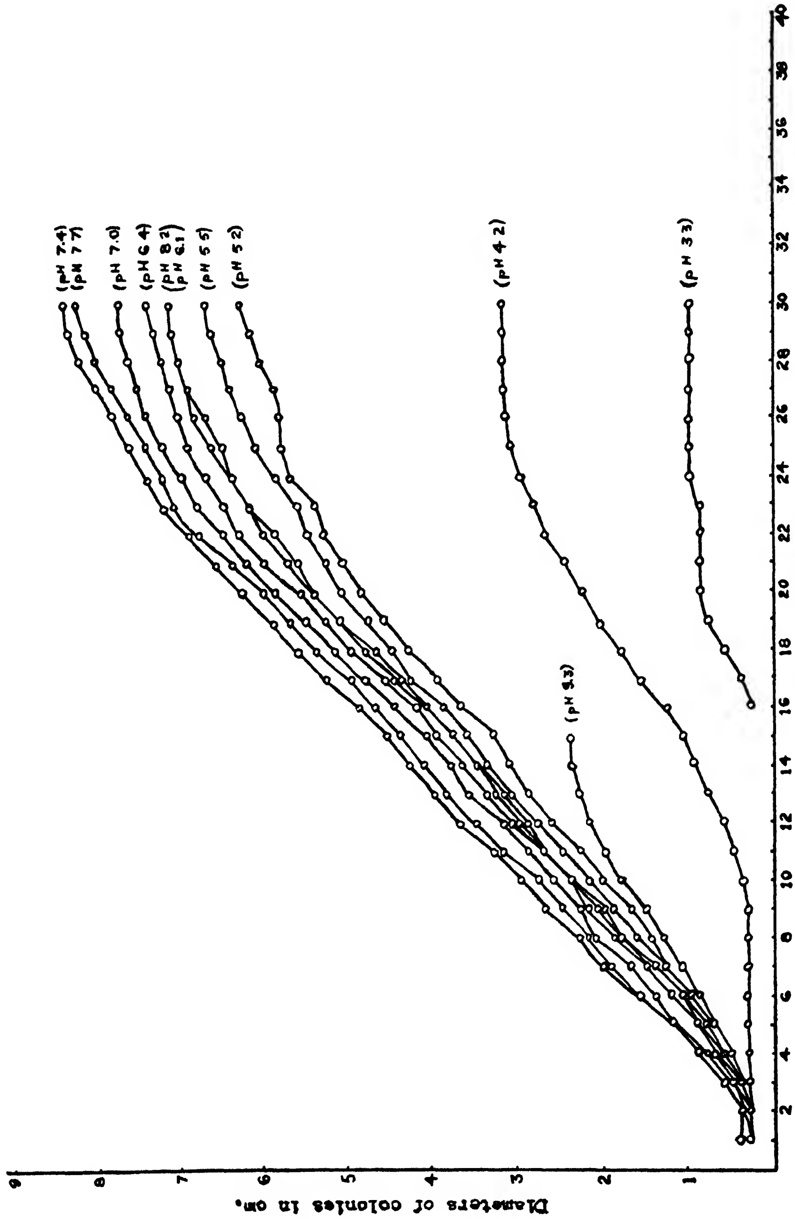


Fig. 3. Rate of growth at constant temperature on beef extract agar with various hydrogen-ion concentrations.

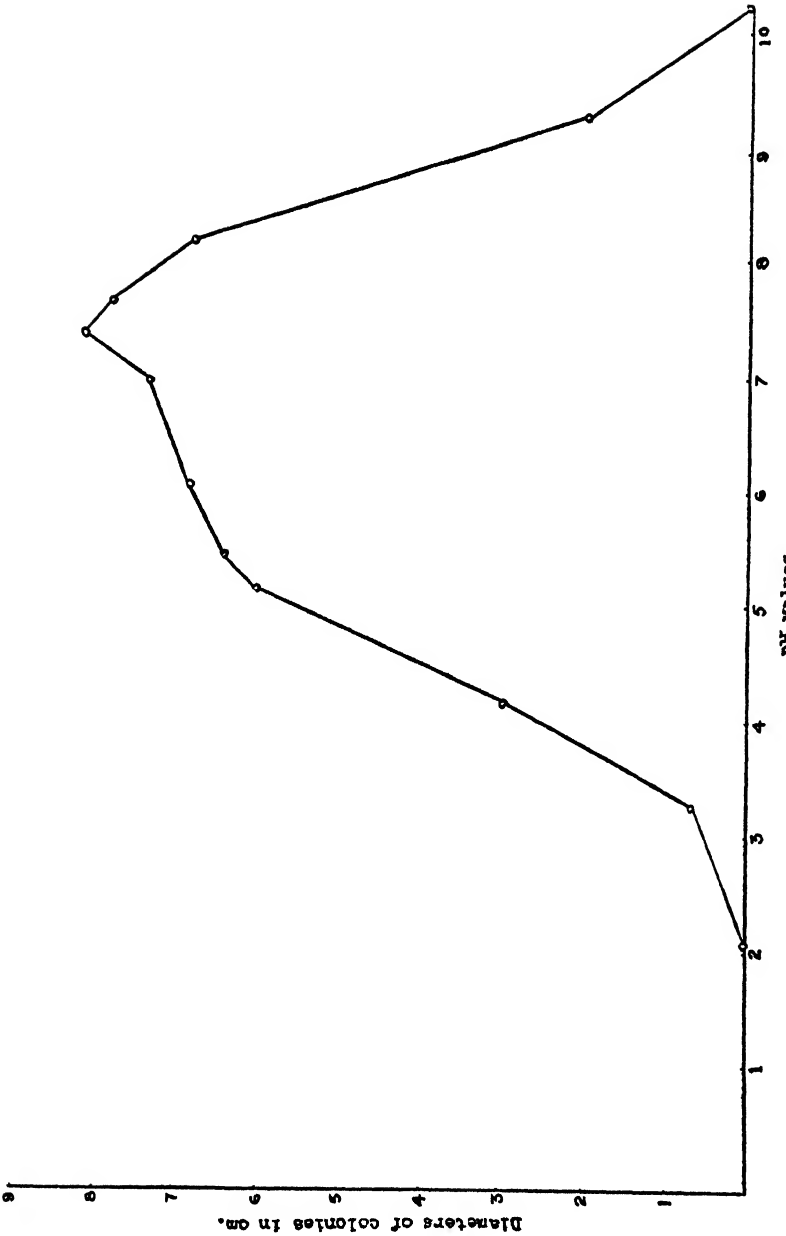


Fig. 4. Maximum growth at constant temperature on beef extract agar with various hydrogen-ion concentrations.

Summary of Cultural Work

The results of the cultural studies described above for the three organisms, *Endomyces capsulatus, E. capsulatus* var. *isabellinus*, and *E. dermatitidis*, but more especially for *E. capsulatus*, may be summarized as follows:

1. Ability of the organisms to grow on a fairly wide variety of media.
2. No growth or very little growth on media lacking or having very little protein or carbohydrate.
3. An increase in the number of conidia and decrease in diameter of hyphae on acid media as compared with fewer conidia and increased thickness of hyphae on media with a high pH. The number of conidia and size of cells may be an index of the hydrogen-ion concentration of the medium.
4. *E. capsulatus* and its variety *isabellinus* show an almost direct change from a yeast-like to mycelium growth macroscopically, as evidenced by the change from a moist colony to a filamentous colony, whereas *E. dermatitidis* shows a macroscopically evident secondary stage in the form of a definite, prickly or coremium-like growth. The secondary stage is identical microscopically, for all the organisms.
5. *E. capsulatus* has a white color, *isabellinus* a light chamois or isabella, while *E. dermatitidis* has a dark brown or cinnamon color.
6. Size and number of various morphological characteristics differ on various media.
7. Reversion to the yeast-like form by growth on serum agar.
8. No growth on litmus milk.
9. The organism shows an optimum temperature of 25° C. with no growth occurring at temperatures above 37° C. and below 8.0° C.
10. The optimum pH is shown to be approximately 7.4 with deviations from the mean, and no growth occurring in a pH higher than 9.3 or lower than 3.3.

Biochemical Reactions

Carbohydrate Reactions.—There have been many conflicting results in the past with regard to the carbohydrate reactions of yeasts and yeast-like organisms. Systems of classification have

been established whereby an organism was placed in a definite taxonomic position because of its production of either acid or gas, or both, or whether or not it had an effect on a carbohydrate. Such a system has been established by Castellani for *Monilia.* Whether any confidence can be placed in a method of that sort is doubtful, first, because it is problematical, at least in some cases, whether absolutely pure sugars are obtainable, and small amounts of impure substances may bring about an altered reaction which may not coincide with the specified phenomenon. That is, a reaction may be indicated as slight or weak, which actually should have been negative. Dekker in 1931 outlined the various methods of sugar fermentation and the faults to be found with each, and for further information, the reader is referred to her work. In the second place, it has been evidenced in the past and frequently noticed at present, that pathogenic organisms of the sort mentioned above have often lost their fermentative abilities on standing in artificial media. The constant subculturing has resulted, as in the case of many fungi, in a change from a pathogenic and virulent parasite to a non-harmful saprophyte, and while this may not necessarily be an index of the sugar reactions of an organism, still we must consider such occurrences as of some significance. It would seem, therefore, that not much reliance must be placed on a system of that sort.

In the work carried out here, stress was laid not so much on the desire to organize and establish a new method of classification, such being altogether too numerous, but to determine whether a yeast-like organism, such as *E. capsulatus,* could produce any acid or gas. For this purpose, Pfanstiehl sugars, which have been found to be considerably above the average, were used. The sugar was added, at the rate of one per cent, to a beef extract broth as prepared previously, to which had been added phenol red as an indicator. The phenol red was made up as a 0.02 per cent solution in distilled water and added in the amount of 1.5 cc. of indicator to 10 cc. of medium. This gave a fairly deep color which proved satisfactory in the work. This particular dye was chosen because preliminary experimentation had shown that the reaction tended more towards alkalinity. Litmus was also used in several series, but the results were not so clear and definite as with phenol red.

A 12-day-old culture on beef extract agar was mashed up with a sterile needle and 5 cc. beef extract broth of the same pH were added to form a suspension. A loopful of this supension was inoculated into Smith fermentation tubes which contained the above medium. All the tubes were grown at 25° C.

The carbohydrates used were those listed in table III. For the sake of clarity, they may be outlined as follows:

Monosaccharides.
  Pentoses:
    Aldoses;
      1-arabinose, 1-xylose
  Hexoses:
    Aldoses;
      rhamnose, dextrose, d-galactose, d-mannose
    Ketose;
      d-levulose
Disaccharides.
  lactose, maltose, saccharose
Trisaccharides.
  raffinose
Colloidal polysaccharides.
  dextrin, starch (soluble), inulin
Glucosides.
  amygdalin, salicin

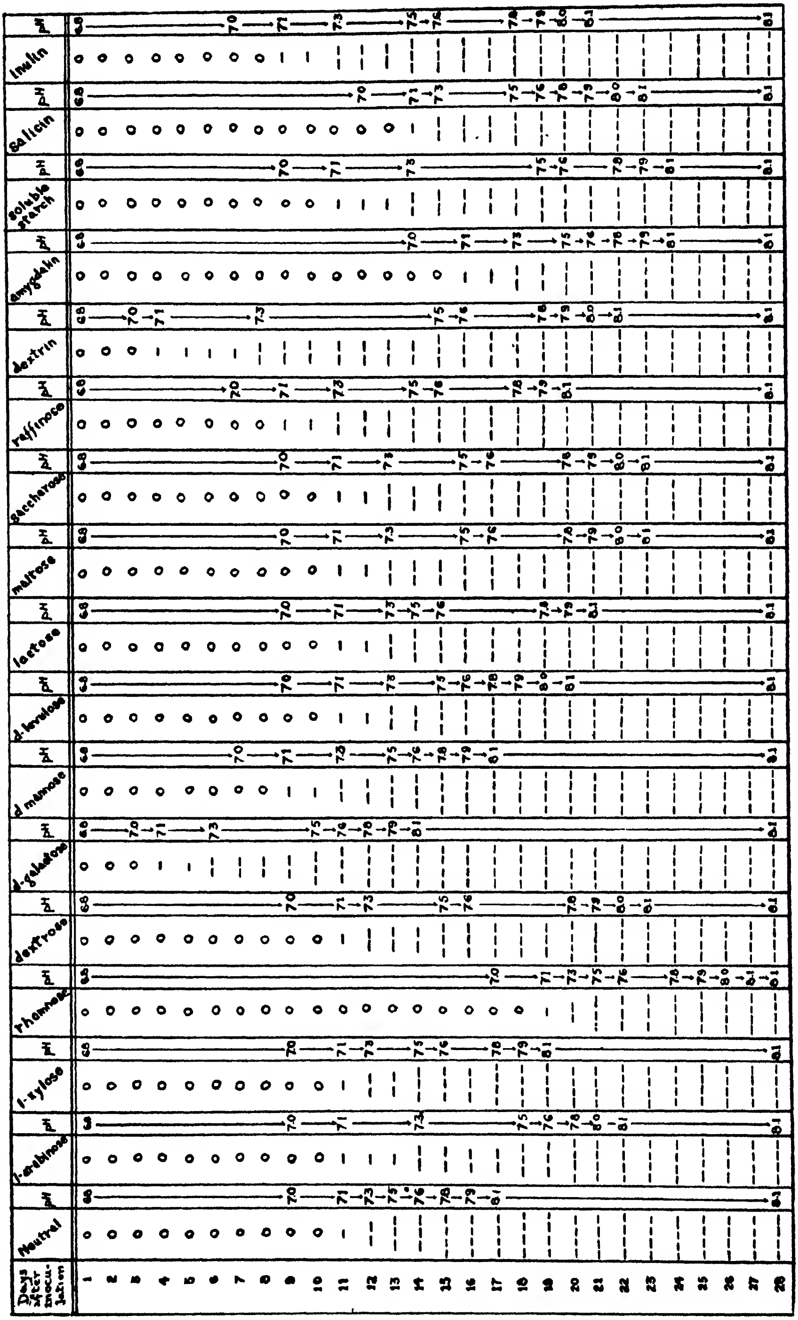
These carbohydrates represent a fairly wide range and include those sugars which are used in the regular routine sugar reactions, as xylose, dextrose, maltose, and lactose.

There will be no attempt at present to explain the work in detail or to offer any complex chemical formulae for possible decompositions, but the reactions and a possible empirical reason for the observations will simply be pointed out.

An examination of table III in which the carbohydrates are arranged in the order of their increasing groups, shows that when compared with the control (the same medium minus the carbohydrate) in the first column there was a changed reaction due to the presence of a carbohydrate. It will be noticed that the control tube showed a change on the eleventh day and a period of reactivity for six days, reaching its maximum on the seventeenth day after inoculation. It is further seen that 1-arabinose, 1-xylose, dextrose, d-levulose, lactose, maltose, saccharose, and soluble starch showed the same initial period of definitely de-

TABLE III

CARBOHYDRATE REACTIONS



monstrable reactivity, by the color changing to red, and that rhamnose showed a lag and hindered the reaction greatly before the color change, this being demonstrable on the nineteenth day. Amygdalin had a somewhat less harmful effect than rhamnose, with the reaction occurring on the sixteenth day, and salicin even less than that, having the initial color change on the fourteenth day. In contrast with the normal, we find that d-galactose and dextrin were very favorable towards color production, inducing a reaction on the fourth day, whereas d-mannose, raffinose, and inulin took effect in perceptible color changes on the ninth day.

It might be added here that three series of tubes were used in each experiment, two series being used to obtain the changes in pH, which were measured by a potentiometer and also a set of colorimetric standards. A set of tubes was prepared with phenol red at various hydrogen-ion concentrations. This method proved very satisfactory for further work, being much more rapid and fairly accurate since readings were made only to the first decimal place. It was found in practically every case that a change in hydrogen-ion concentration occurred two days before a color change, except in the case of d-galactose and dextrin where the reaction was more rapid, taking place on the third day. This latter reaction may be explained somewhat by the fact that the two carbohydrates are very favorable to growth, since the color change is due to the growth of the organism which brings about a reaction in the medium as a result of the utilization of the nutrients.

A striking feature of these reactions is the varied range of reactivity as may be seen in fig. 5. No explanation, outside of the rate of utilization of the carbohydrate, can be given at the present time for this phenomenon. As compared with the control, the range for dextrin is very large. By the range of reactivity is meant the period over which the color changes and the decrease in hydrogen-ion concentration take place, coming to an end point of an approximate pH of 8.1. The various carbohydrates present various ranges which are clearly evident in fig. 5.

Soluble starch, added to the solution at the rate of 0.2 per cent, showed a partial hydrolysis on the nineteenth day as evidenced

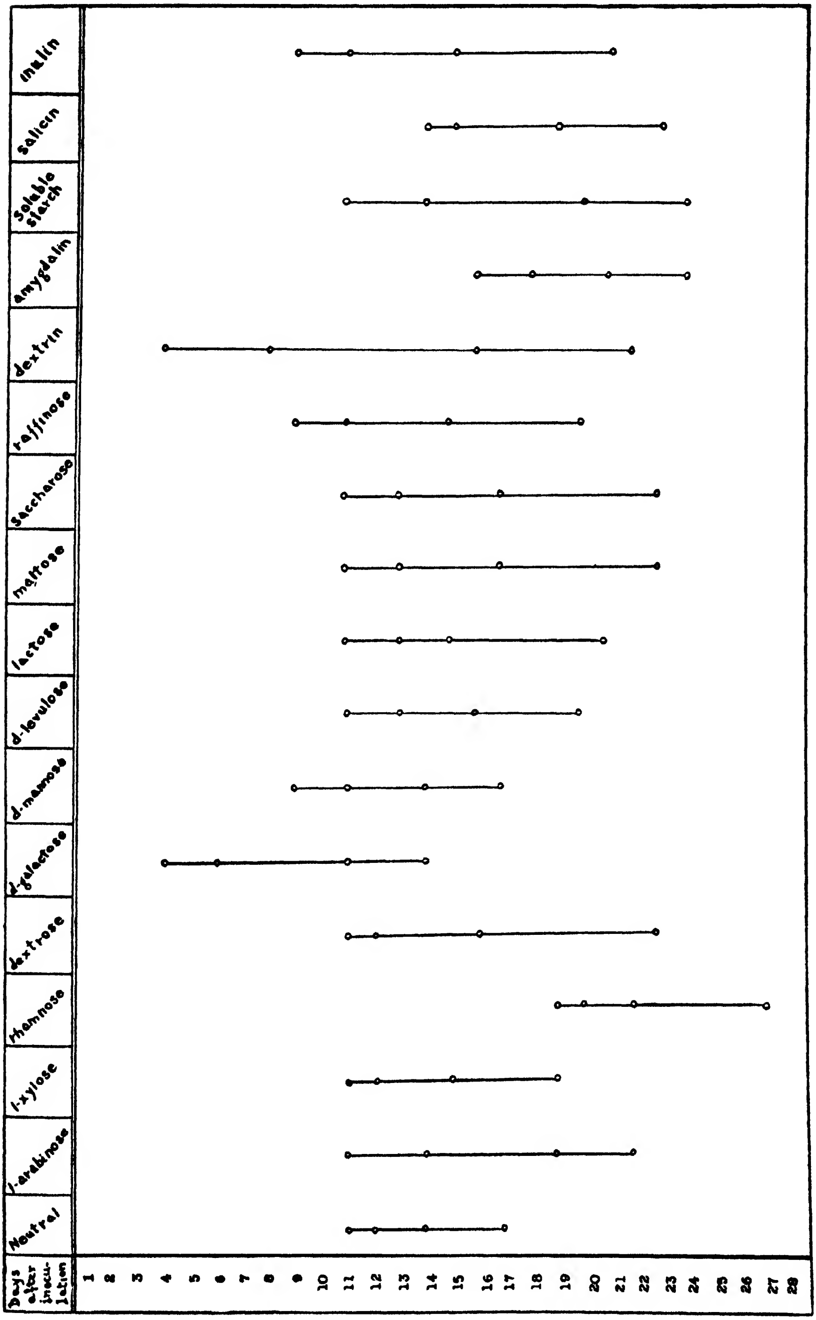


Fig. 5. Range of reactivity of carbohydrates.

by a reddish-brown color on addition of a dilute iodine solution. Fehling's solution reduced to cuprous oxide as shown by a faint reddish-violet color. There was no complete hydrolysis at the end of the experiment.

It may also be noted that in its production of alkalinity the reaction proceeded in every case from the aerobic portion of the Smith tube, or rather from the bulb, to the arm of the tube, or the closed portion. In other words, there was a diffusion of ions from the aerobic to the anaerobic. This of course was to be expected, since the organism is strictly aerobic, as will be shown later, and utilized all of the little material available, before growing towards the anaerobic portion. In every case, however, no matter how marked the reaction, the color change in the arm was comparatively slow.

Proteins are broken down very easily by reacting substances, and the cultural experiments have shown that *E. capsulatus* requires some protein, its derivatives, or carbohydrate, for growth. It is also known that these proteins and their derivatives may be further reduced or broken down to amino acids, peptones, peptides, and hexone bases and other substances, whereas higher carbohydrates may be reduced to simpler sugars. Ammonia is often found to be a product in the hydrolysis of proteins. In the presence of sugars, amino acids have characteristic reactions, particularly in an alkaline solution, and these have been dealt with by several authors, recently by Watanabe ('32). This author lists many reactions and covers the literature of the field rather well, and the reader is referred to his paper for detailed information. Euler and his associates, in some work carried out in 1926 and 1927, found that the reaction between amino acids and sugars which were reversible, took place at an equimolecular ratio and that their velocity became greater in an alkaline medium. This may account for the rate of activity as noticed in table III. The work of several others seems to point to the conclusion that a reaction between amino acid and sugar requires a neutral reaction and a fairly high temperature, whereas Waldschmitt-Leitz and Rauchalles observed that the optimum hydrogen-ion concentration for the reaction between dipeptides and glucose was pH 8.1. This seems to coincide with the results obtained here.

It is clearly evident from the experimental data that, instead of acid or gas or both, the carbohydrates here used induced the production of an alkaline condition. In addition to the protein decomposition substances as mentioned above, ammonia may be an end product. This substance, where present in fairly large amounts, brings about a strongly alkaline condition. To test for it, several cc. of the culture broth were poured into a test-tube, and a pinch of anhydrous sodium carbonate (Na_2CO_3) was added. The tube was shaken and a rather strong odor of ammonia was given off. It is possible that, besides the evident ammonia, hexone bases, as arginine, lysine, and histidine, which are alkaline in solution, are formed as products of the protein derivatives in the medium and that in addition to the sugar reaction they cause a decrease in the hydrogen-ion concentration.

Indol and Skatol.—Reactions which have long been used in bacteriological technique but which have not received much attention until lately, due to the additional knowledge and better methods which are applied, are those of indol and skatol. The work of such investigators as Pittaluga ('08), Goré ('21), Holman and Gonzales ('23), Morelli ('09), Sasaki ('10), Zipfel ('12), Krumwiede and Pratt ('13), Fellers and Clough ('25), Koser and Galt ('26), and several others has greatly added to the methods of technique in investigations. Tests have been advocated from time to time, the importance of which lay in their specificity for the reaction. Fellers and Clough list about thirteen tests which have been applied, some successful some not.

Indol and skatol are protein derivatives and their determination rests on the presence of tryptophane. From it they are broken off by a deamidization to form first indol proprionic acid, then indol acetic acid, and finally indol or skatol. The medium to be used in such a reaction must therefore contain a supply of tryptophane sufficient to determine whether the organism would actually be capable of breaking it down to indol or skatol or both. For this purpose, it was necessary to use peptone plus 0.1 per cent casein in water to insure good growth and also to comply with the requirements as stated. The broth was inoculated and the organism was allowed to grow at 25°C.

In the first test the Gnezda ('99) oxalic acid principle was

applied. Strips of filter paper were placed in a warm solution (saturated) of oxalic acid. On cooling, crystals of oxalic acid remained on the strips. The paper was then dried well and inserted in the mouth of the flask under aseptic conditions, so that it was pressed against the side of the flask and just above the surface of the broth. If indol is formed it volatilizes and colors the oxalic acid pink. In these tests for *E. capsulatus*, a very faint pink was barely discernible. This test has been advocated rather strongly by the Society of American Bacteriologists for regular routine work in bacteriology.

A test that was applied successfully is the Ehrlich-Böhme technique which consists of two solutions. Solution 1 contains 1 gm. para-dimethyl-amino-benzaldehyde, 95 cc. ethyl alcohol (95 per cent), and 20 cc. hydrochloric acid, concentrated. Solution 2 is a saturated solution of potassium persulphate ($K_2S_2O_8$). In the experiment, 5 cc. of solution 1 are added to 10 cc. of the culture fluid, then 5 cc. of solution 2, and the mixture is shaken. A faint red color appearing about five minutes later indicated a weakly positive reaction. This method has proven rather successful for indol. Steensma ('06, '06a) substituted vanillin for the para-dimethyl-amino-benzaldehyde, but this was not applied here.

The Salkowski ('83) nitroso-indol test was negative for indol.

Skatol was tested for by the Sasaki ('10) methyl alcohol test. This method consisted of adding to the broth to be tested about four drops methyl alcohol and an amount of concentrated sulphuric acid equal to the broth. The acid contained a trace of ferric salt. A reddish-violet color indicated a positive skatol reaction.

Under the proper conditions, indol and skatol may be produced by *E. capsulatus*.

Relation to Free Oxygen.—Aerobiosis has often been considered important in experimental work. Organisms are classified as strict aerobes, facultative aerobes, or facultative anaerobes and strict anaerobes. In order to find the position of *E. capsulatus* in this classification, tubes of broth were prepared and inoculated by the Liborius method (Zinsser, '29) and kept at 25° C. Cultures were kept at the same temperature and in the

same broth, but were plugged only, allowing oxygen to enter. No growth occurred in the former while a luxuriant growth occurred in the latter. Agar stab cultures were negative for growth in the stab, but positive on the surface. The relationship to free oxygen was also demonstrated in the carbohydrate reactions as mentioned previously.

We may conclude, therefore, that *E. capsulatus* is a strict aerobe, at least in so far as its growth on agar after a period of time has demonstrated. When in the yeast form, anaerobic cultures showed slight growth, a condition of facultative anaerobiosis. Continued growth on an artificial substrate has converted it into a strict aerobe.

Reduction of Nitrates.—The tests for nitrate reduction as advocated by the American Society of Bacteriologists were inconclusive and unsatisfactory. Ammonia was found to be present, but that was apparently due to the breakdown of the peptone and other protein decomposition products. Trommsdorf's method was also indefinite, being negative in general, but at times gave a slightly colored reaction.

Production of Hydrogen Sulphide.—The formation of hydrogen sulphide in culture has often been concerned with a toxic action of the lead salt or lead acetate in the medium toward certain bacteria. Whether hydrogen sulphide would be produced here was of course problematical. However, a lead acetate agar put up by the Digestive Ferments Co., "Bacto lead acetate agar," which is claimed to contain too little lead salt to be toxic and yet was favorable for the demonstration of the hydrogen sulphide, was used. Making stab cultures was of course illogical, for reasons pointed out before, and so surface inoculations were made and the cultures incubated at 25° C. A slight brownish coloration was found to occur directly around the colony after thirty to forty days, and increased somewhat on standing.

No definite method has been advocated for the above experiment, and since the results were slightly evident even though the period was a great deal longer than for bacteria, the reaction might be considered positive.

Gelatine Liquefaction.—Tubes of 15 per cent meat extract gelatine were inoculated by stabbing and incubated at 25° C. A

slow liquefaction took place between 30 and 40 days, and in some cases even longer than that. Liquefaction began at the surface and proceeded downward. This may be correlated with the growth of the fungus.

Reaction to Light

A great deal of experimental work has been done in the past, and much is being attempted at the present, with respect to the

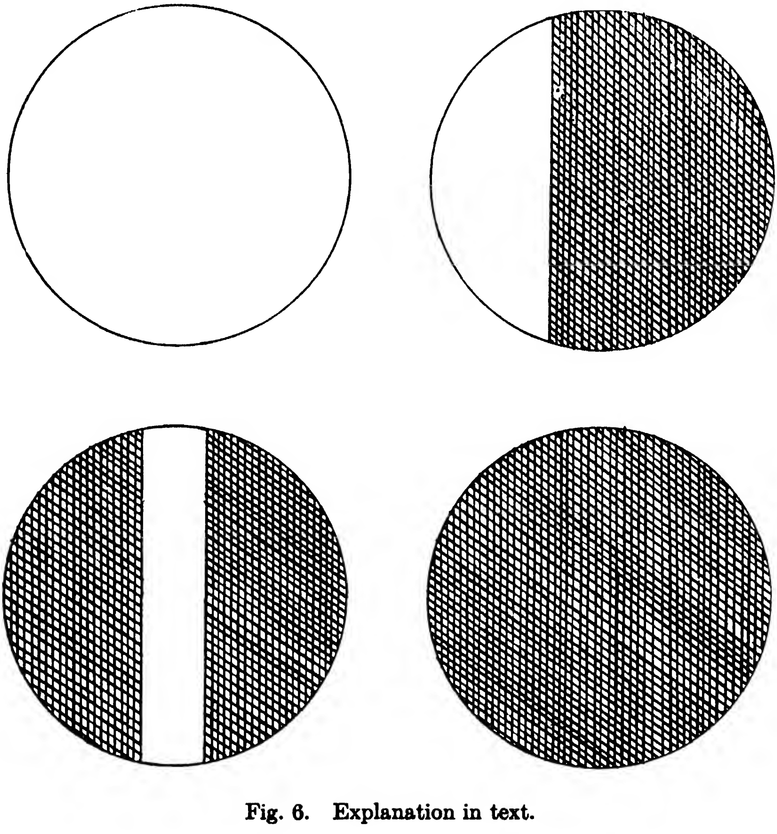


Fig. 6. Explanation in text.

action of light on higher plants and also microbiology. It is accepted as a fact by many that plant growth and vitality can be greatly altered, either for better or worse, by continued treatment under variously colored lights. No great amount of work, however, has been done on the action of the primary colors on fungi or bacteria. Several workers have found a destructive

action of light on the lower organisms, and Rahn has found that red and green light have no effect while blue light has a very harmful action, with the degree of destruction decreasing in the violet and ultra-violet portion of the spectrum.

Effect of White Light on Growth.—To determine the differential action of light and darkness on *E. capsulatus*, series of plates were

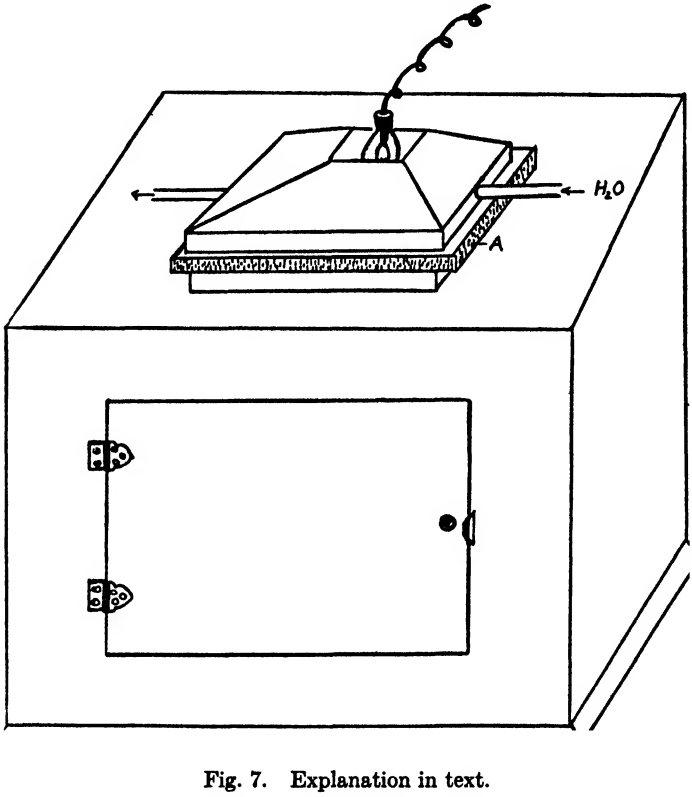


Fig. 7. Explanation in text.

covered with opaque black paper of the sort used in covering photographic plates, as illustrated in fig. 6, the portions with the crossing lines representing the covered areas. The plates were treated as follows: plate A was inoculated in the center and completely exposed to the light; plate B was covered as shown and was inoculated at a point about 1.5 cm. from the rim of the plate, or about 5 cm. from the uncovered area. This plate was used to determine whether the organism would grow towards the

light or not. The plates covered as in C were inoculated in the center of the portions covered, and plate D was inoculated as in plate A and served as the complete darkness plate. Nutrient agar was used. These plates were placed in a light-proof container illustrated in fig. 7, at room temperature. A General Electric mazda bulb of 50 watts and 115 volts was used as a source of light. A flow of water was kept constant beneath the source of light to prevent the heat from reaching the interior of the container. A sheet of colorless glass (A) was kept between the flowing water and the cultures. Several cultures of each series were kept in the container and the experiment was performed on several different occasions. Plates prepared as above were kept at room temperature and were subject to diffuse daylight and darkness. Growth at the end of 24 days showed no cultural or microscopical differences in any case, except for a slight increase in diameter of three plates kept in the freely circulating air. This small number of attempts seemed to indicate that light had no effect on growth.

Effect of Red Light on Growth.—It has been pointed out that red light stimulated growth in higher plants but, according to Rahn, had no effect on lower organisms. Shrewsbury found that when cultures of *Willia* were placed at a distance of 4 inches from a Wratten safelight No. 1 screen, illuminated by a 60-watt gas-filled lamp, with the temperature of the dark room ranging from 23 to 28° C., growth was more rapid and more luxuriant than in the dark or diffuse daylight, as expressed by a hastening of spore formation. He attributed this increased activity to a reflex of increased growth energy, with red light acting as a stimulant. However, he adds that much the same growth was obtained in cultures grown at 30° C. as in those grown at room temperature, so that it was very likely that the heat and not the red light was the activating agent.

To avoid this condition, the light-proof container as described above (fig. 7) was again used. This time a red bulb of the same intensity as before was used and a plate of red glass replaced the colorless glass. The same medium of the same pH was used here too. Cultures were grown at room temperature in the dark and diffuse daylight as controls. After 27 days it was found that

those cultures under red light displayed no cultural or microscopic differences from those grown in the dark and daylight, and showed no change from those in white light and total darkness, except for a small increase in diameter which may be ascribed to the extra time of 3 days.

Reaction to Dyes

The rôle of certain dyes in medical work has received much critical and experimental attention for a number of years. Their application for therapeutic purposes has resulted in clinical cures in various cases and has had no effect in others. Particular dyes, as methylene blue, gentian violet, and crystal violet, have been used locally or intravenously for skin lesions in cases of blastomycosis, coccidioidal granuloma, sporotrichosis, monilial infections, and other diseases both of mycological and bacteriological etiology. Some of these have yielded favorable results as mentioned, but the value of the dyes applied is empirical since dye therapy rests on no definite scientific basis, according to Spring ('29). Faber and Dickey ('25) treated 15 infants afflicted with thrush, with local applications of a 1 per cent aqueous solution of gentian violet and found that 50 per cent showed an apparent cure in one day or less; 36 per cent in from 2 to 3 days; and 14 per cent in from 4 to 5 days. In several cases, however, the lesions returned at various intervals, and again some disappeared after one application while others resisted for several applications. In general, the lesions seemed to become smaller after continuous applications and to disappear. As a result, Faber and Dickey advocate a trial of the dye for prophylactic measures and also for therapy. Churchman ('20d), working on chemotherapy with gentian violet *in vitro*, advised careful considerations of the amount of bacteria affected, before any conclusion as to the therapeutic value of the dye be evaluated. Sanderson and Smith ('27) postulated the possibility of the utilization of gentian violet dye for the treatment of blastomycosis.

It has been known and recorded since the days of Koch that certain aniline dyes have a "bacteriostatic" effect on the culturability of various bacteria. The viability of the organisms is

diminished to such an extent that they lose their power to multiply. This selective action of the dyes is very remarkable, certain organisms growing very abundantly and luxuriously on a medium containing gentian violet in a rather high concentration, whereas other organisms which are very resistant to harmful factors do not grow at all. This high selectivity or specificity was attributed not only to gentian violet, but also to others, as crystal violet and various members of the tri-phenyl methane series of dyes.

In early work on dyes, smears and broth cultures were used, but it was found that the bacteria ceased growing or were killed in the smears and that various concentrations of dye in the broth had practically the same effect. Later work (Churchman, '12) was performed on the divided agar plate to determine whether the reaction would be the same. This method consists of inserting a metal strip (Halsted's aneurysm metal) across the diameter of the petri dish and then pouring the agar on one side and allowing it to cool. The agar containing the dye is poured on the other side of the strip. When the agar hardens, the metal strip is lifted out with sterile forceps. Thus one half of the plate contains plain agar and the other half the dye-containing agar. This method has been used by several investigators, including Sanderson and Smith.

Churchman ('12,' 20, '20a, '20b, '20c, '20d, '20e, '21) found that a parallelism with the reaction of the Gram stain could be made. That is, considering as violet-positive those organisms which were inhibited in growth by a certain concentration of a dye, gentian violet for instance, and as violet negative those upon whose growth the dye had no effect, then it was found that a great number of Gram negative organisms were also violet negative. This is a general rule, with a few outstanding organisms being exceptions.

The same author also found that the selective action of the dye may be expressed in one of two ways. The dye may be toxic to the violet-positive organisms when a direct application is made, or a very strong inhibitory action is expressed when it is incorporated in the medium. On the other hand, the dye is not toxic to violet-negative organisms, and further, no inhibitory

action is expressed except in very strong concentrations when it is incorporated in the medium. His experimental evidence pointed to a dilution of 1 : 1,000,000 as capable of stopping growth, and 1 : 2,000,000 as possibly retarding it.

This work was confirmed by Krumwiede and Pratt ('13), who used dahlia agar, and also they confirmed the belief that the action was quantitative. They further observed that several dyes, in addition to those already mentioned, had this specific action. This work then called forth several applications of this principle to culture media, as that of Petroff ('15) which was used by that author to isolate tubercle bacilli from the sputum and feces, and that of Farley ('20) as a restrainer in the isolation of pathogenic molds. Farley found that a dilution of 1:500,000 inhibited the growth of Gram positive bacteria.

Later work on this problem showed that there might exist two types of organisms within a single strain, one which might grow vigorously on gentian violet media, and the other not at all, yet both showing the same stain and cultural characteristics. Also, heavy and repeated inoculations of violet-positive organisms would give fair and even good growth, and on this point Churchman ('20e) made the following statement: "This would indicate that bacteria do not, as is commonly supposed, act as isolated individuals; they possess the power, in numbers, of accomplishing effects which, alone, they are incapable of. The nature of this community of action it is at present impossible to guess at." The same author (Churchman, '21) placed dead bacterial bodies between living bacteria and gentian violet media and found that the Gram positive organisms grew, the dye having no effect. He attributed this occurrence either to a filtration or a stimulation of growth. The same year Churchman and Kahn ('21) found that a number of cells could accomplish more than a single cell, hence the communal action belief was further emphasized.

Work on dyes was not confined to bacteria alone, for Lewis ('30) found that a certain number of dyes failed to inactivate the virus of chicken tumor while many had a harmful effect in certain concentrations. Several papers have been published showing the action of certain of these dyes on various fungi, but only in a qualitative way; Greenbaum and Klauder ('22) tested the action of gentian violet

as advocated by Farley ('20a); Sanderson and Smith ('27) found that dilutions up to 1 : 500,000 inhibited *E. dermatitidis* in its yeast-like form; Clark ('27) showed that no growth occurred in a yeast-like organism and its mycelial form in dilutions from 1 : 100 to 1 : 25,000 and that it gradually increased from 1 : 50,000 to 1 : 1,000,000, which gave good growth. No quantitative determinations of the colony growth were made. Stearn and Stearn ('29) found that several fungi, including *E. dermatitidis*, were inhibited at various concentrations of gentian violet, with the organism being affected at 1 : 500,000.

The later work of Churchman indicated that the "bacteriostatic properties" of dyes ascribe to them the ability to interfere with the reproductive mechanism, which he terms "genesistasis," without killing or in any way interfering with their other properties. This same phenomenon has been found both qualitatively and quantitatively to hold for *E. capsulatus*.

Since the author could find that no particularly quantitative results had been obtained for ascomycetous fungi, at least for the hyphal form, it was decided to investigate the problem of the dye reaction. For this purpose, several dyes, picked at random, were used. These are as follows:

- Dyes of the nitro, azo, and oxyquinone groups.
  - Dyes of the azo group:
    - *orange G*—acid—(National Aniline and Chemical Co.)
    - *Sudan III*—weakly acid—(E. Merck)
  - Dyes of the oxyquinone group:
    - *alizarin*—acid—(E. Merck)
- The quinone-imide dyes.
  - The thiazins:
    - *methylene blue*—basic—(Coleman and Bell Co.)
  - The azins:
    - Amido-azins or eurhodins;
      - *neutral red*—weakly basic—(Coleman and Bell Co.)
    - Safranines;
      - *safranine A*—basic—(Coleman and Bell Co.)
- The phenyl-methane dyes.
  - Tri-phenyl methane derivatives:
    - Di-amino tri-phenyl methanes;
      - *light green S. F. yellowish*—acid—(Coleman and Bell Co.)
    - Tri-amino tri-phenyl methanes (rosanilins);
      - *basic fuchsin*—basic—(Coleman and Bell Co.)
      - *crystal violet*—basic—(Coleman and Bell Co.)
      - *aniline blue*—acid—(National Aniline and Chemical Co.)

The xanthene dyes.
Fluorane derivatives:
eosine B—acid—(Coleman and Bell Co.)
Phenolphthalein and the sulphonthaleins:
phenol red or *phenol-sulphonphthalein*—acid—(Dr. T. Schuchardt, G. m. b. H. Chemische Fabrik)
The natural dyes
Brazilin and haematoxylin:
haematoxylin (Coleman and Bell Co.)

These dyes were incorporated in the media, nutrient agar (product of Digestive Ferments Co.) at a pH of 6.8, in the following concentrations: .00001; .000025; .00005; .000075; .0001; .00025; .0005. Several plates were used for each concentration of the dye, but only three plates for each are recorded in the tables for reasons stated previously. These plates were inoculated in the same manner as were those in the temperature and pH experiments, a broth of pH 6.8 being used here. The plates were kept at room temperature, which showed slight changes from day to day but not enough to affect the results seriously. The diameters of the colonies were measured daily at approximately the same hour each day. Inasmuch as the colonies may show slight irregularities in peripheral growth, these measurements may not be considered absolutely correct. However, if the shape of the colony was irregular, several diameters were measured and the mean taken as representative of that colony. Where contaminations occurred, as has been explained previously, the plates were discarded.

It is to be noted that these experiments were carried out on several different occasions and that the figures in the tables denote the mean of a representative series. Since preliminary experiments with these dyes had given some seemingly strange results, microscopic examinations were made daily, in the case of the crystal violet and methylene blue series, and then, some time after growth had started, in the case of eosine B.

Several of the dyes produced no effect on the growth of the organism. These dyes were orange G, Sudan III, alizarin (table IV), safranine A, light green, basic fuchsin, aniline blue, phenol red, and haematoxylin. Neutral red was also used, but, as was expected, the results showed no difference from the normal control, the same being true for the other dyes.

If normal conditions are maintained for the plates, that is, if there is no drying out and no change in temperature the colonies grow at a rate of speed which is fairly constant as long as there is sufficient nutrient material for the organism. However, when the plates are kept in an atmosphere which allows drying out of the agar and when the amount of nutrient material is relatively small for the particular organism, the colony will show a decrease

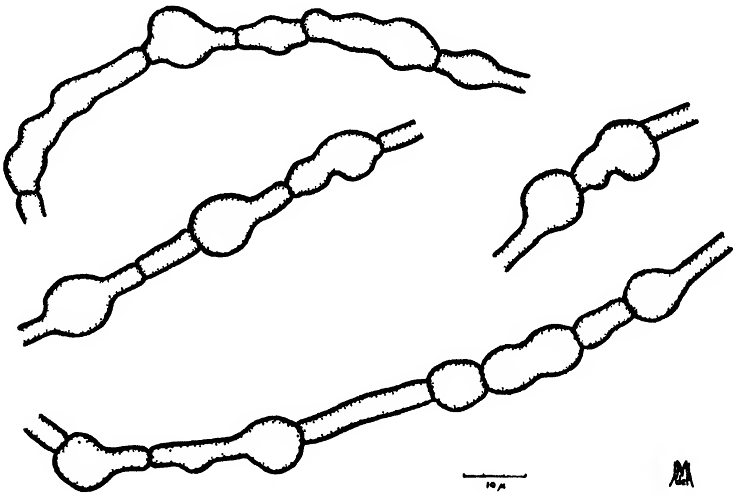


Fig. 8. Mycelium on .00025 per cent crystal violet agar.

in growth rate. Thus, in the former case, the growth curve would be a straight line for a considerable portion, depending of course on the rapidity of growth of the organism compared from day to day, which in this case was sufficient to cover the plate almost completely before drying of the substrate. An initial lag on artificial substrates, as agar, must be taken into consideration. In that case the curve would tend to be sigmoid, that is, there would be an initial lag due to an acclimatization of the organism to the medium, a portion of increased activity which would be a sharp rise, and then a portion of decreased activity due to factors mentioned previously.

The data of the growth on the several non-affecting dyes

TABLE IV

MEAN DIAMETERS IN CENTIMETERS OF COLONIES GROWN IN VARIOUS CONCENTRATIONS OF ALIZARIN, AT A TEMPERATURE OF APPROXIMATELY 22° C.

Nutrient agar (product of Digestive Ferments Co.) pH 6.8							
Days after inocula-tion	Percentage concentration of dye						
	.00001	.000025	.00005	.000075	.0001	.00025	.0005
1	0 3	0.3	0.3	0.5	0.4	0.4	0.4
2	0.3	0.3	0.3	0.5	0.4	0.4	0.4
3	0.3	0.3	0.3	0.5	0.4	0.4	0.4
4	0.5	0.6	0 6	0.8	0.7	0.6	0.6
5	0.6	0.7	0.8	0.9	0.9	0.8	0.8
6	0.8	0.8	1.0	1.0	1.1	0.9	1.0
7	1.0	1.0	1.1	1.2	1.2	1.0	1.2
8	1.3	1.3	1.4	1.4	1.5	1.3	1.5
9	1.5	1.6	1.6	1.6	1.6	1.6	1.6
10	1.7	1.7	1.8	1.8	1.9	1.8	1.9
11	1.9	1.9	2 0	2.0	2.1	2.0	2.0
12	2.0	2.1	2.2	2.2	2.3	2.2	2.3
13	2.2	2.3	2.4	2.4	2.5	2.4	2.5
14	2.4	2.5	2.6	2.6	2.7	2.7	2.7
15	2.7	2.8	2.8	2.9	3.0	2.9	3.0
16	2.9	3 0	3.1	3.0	3 2	3.2	3.2
17	3.1	3.2	3.3	3.3	3.4	3.4	3.4
18	3.3	3.4	3.5	3.5	3.6	3.5	3.6
19	3.6	3 6	3.7	3.7	3.7	3.7	3.7
20	3.7	3.7	3.9	3.8	3.9	3 9	3.9
21	3 9	3.9	4 0	4 0	4.1	4 0	4.1
22	4.1	4.1	4.2	4.2	4.3	4.2	4.3
23	4.2	4.3	4.3	4.3	4.4	4.4	4.4
24	4.5	4.5	4.5	4.5	4.7	4.6	4.6
25	4.6	4.6	4.7	4.7	4.8	4.7	4.7
26	4.8	4.8	4 8	4.8	5.0	4.9	4.9
27	4.9	4.9	5.0	5 0	5.1	5.0	5.1
28	5.1	5.1	5 1	5.1	5.2	5.2	5.2
29	5.2	5.2	5.3	5.3	5.3	5.3	5.4
30	5.4	5.4	5.4	5.4	5.6	5.5	5.6
31	5.6	5.5	5.7	5.6	5.7	5.6	5.7
32	5.8	5.7	5.8	5.8	5.9	5.8	5.9
33	5.9	5.9	6.0	5.9	6.1	5.9	6.1
34	6.1	6.1	6.2	6.1	6.3	6.1	6.2
35	6.2	6.2	6.3	6.2	6.4	6.2	6.4
36	6.4	6.4	6.5	6.5	6.6	6.4	6.6
37	6.6	6.6	6.6	6.6	6.7	6.5	6.7

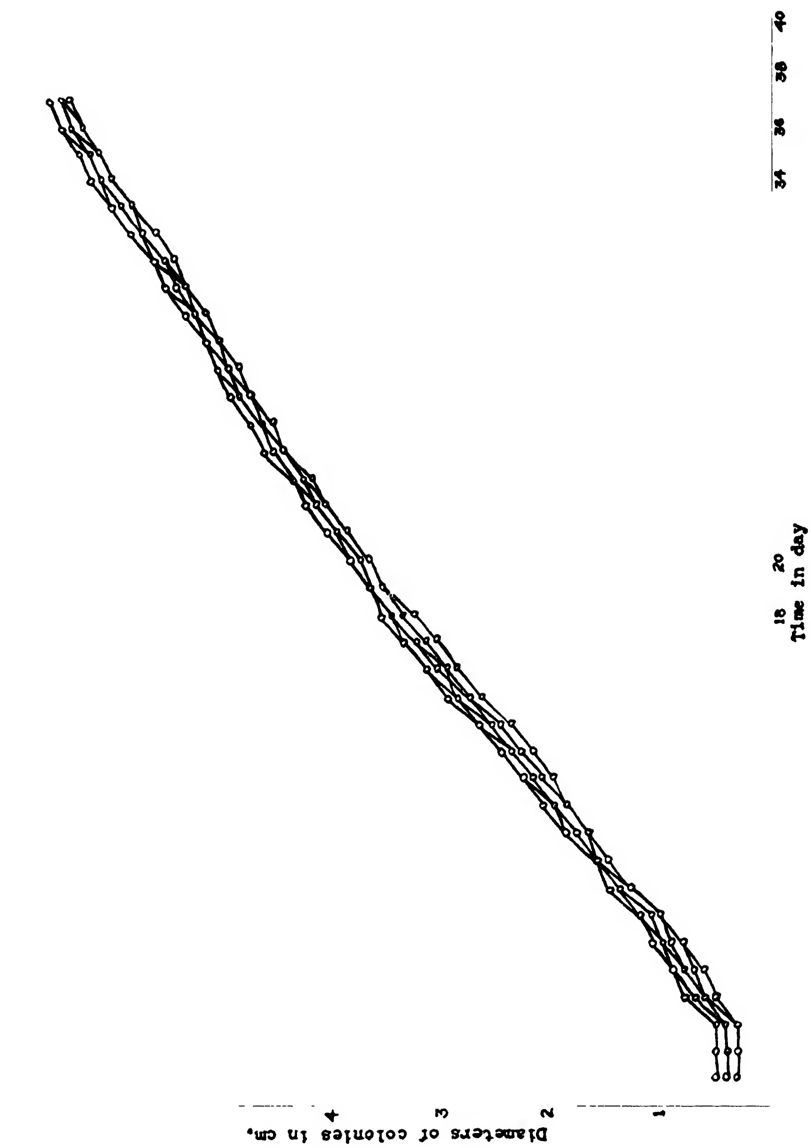


Fig. 9.

showed that the rate was practically the same in each case, and if the diameters of the colonies in cm. were plotted against the time in days, for each concentration of the dye, one would find this to be the case. This is illustrated in fig. 9, the growth rate for

alizarin, results representative of these dyes. The differences in the curves are within the range of error, so that in general we may

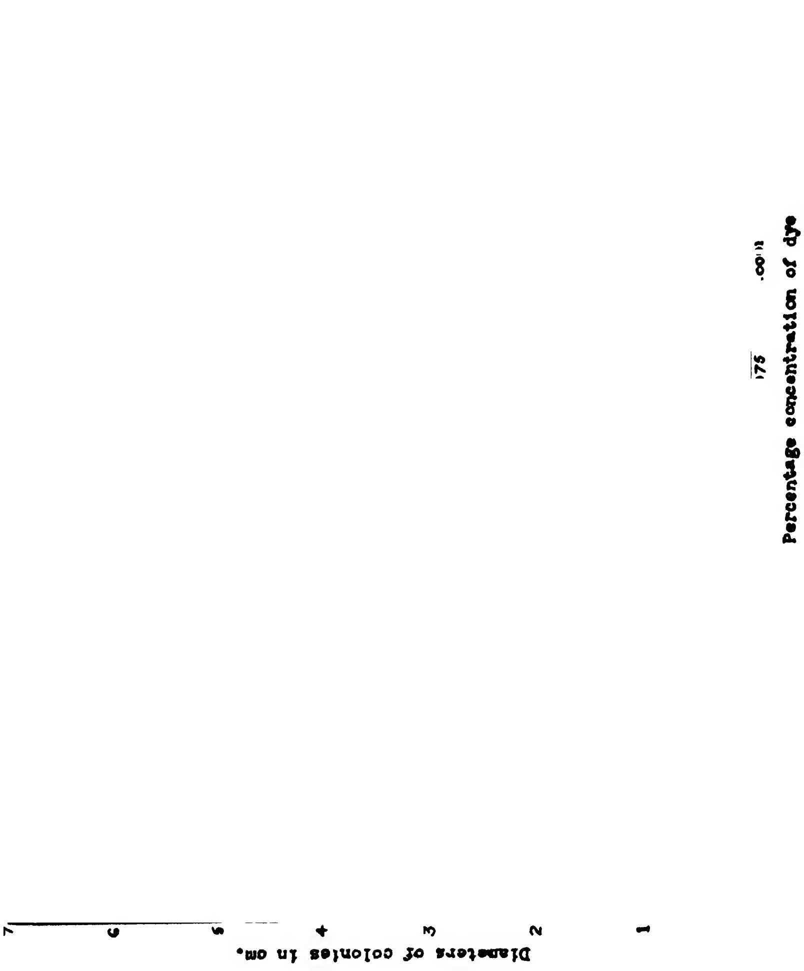


Fig. M grov mperature and same pH on nu ious of alizarin.

say that the growth rate is the same. Except for the initial lag and a slight curve due perhaps to utilization of nutrient materials

or drying of the agar, the line is about straight. When the maximum points of growth for each concentration is plotted, that is, diameter of colony against percentage concentration of dye (fig. 10), it is found that a straight line results, with perhaps some excusable error. In other words, growth is identical for all the concentrations of dye, at least in the observations made here.

In dealing with the other dyes, as crystal violet (table v), methylene blue (table vi), and eosine B (table vii), a striking difference in growth was observed. The cultures of crystal violet grown under the same conditions as those above presented a growth which was proportional, within a range of limits, to the concentration of the dye. Like results were found to be true for methylene blue, but not quite so well marked.

Colony measurements were made daily, and, as may be seen in table v, the growth was inhibited in the higher concentrations to the point of complete cessation. Along with the measurements, microscopic examinations were also made, and it was found that on the media of higher concentration of dye there was a corresponding decrease in production of reproductive parts. In other words, the number of asci with the ascospores gradually diminished on the increasing concentration of dye media as compared with the normal growth. A well-marked feature was the development of thick walls in the hyphae, as may be seen in fig. 8 which illustrates variously thick-walled swellings, chlamydospores and hyphae, taken from a culture of .00025 concentration, forty days after inoculation. The cellular material stained heavily, and showed granular cytoplasm and a reduction in the number of nuclear divisions. An increase in the number of swellings, cellular contents, and thickness of walls, as well as the number of chlamydospores and terminal hypnospores, is a condition which is usually associated with unfavorable phenomena. Similar characteristics were present approximately three months later. Macroscopically, the colonies on the higher concentration of crystal violet showed a growth upwards on the inoculum and not until 15 days after inoculation did any growth appear on the agar and then very little. In the case of methylene blue, however, growth was flat and took on a blue color very soon after inoculation.

TABLE V

MEAN DIAMETERS IN CENTIMETERS OF COLONIES GROWN IN VARIOUS CONCENTRATIONS OF CRYSTAL VIOLET, AT A TEMPERATURE OF APPROXIMATELY 22° C.

Nutrient agar (product of Digestive Ferments Co.) pH 6.8

Days after inoculation	Percentage concentration of dye						
	.00001	.000025	.00005	.000075	.0001	.00025	.0005
1	0.3	0.2	0.3	0.2	0.4	0.3	0.3
2	0.3	0.2	0.3	0.2	0.4	0.3	0.3
3	0.3	0.2	0.3	0.2	0.4	0.3	0.3
4	0.5	0.3	0.3	0.2	0.4	0.3	0*
5	0.7	0.5	0.4	0.3	0.4	0.3	0
6	0.9	0.6	0.5	0.3	0.4	0.3	0
7	1.0	0.8	0.5	0.4	0.4	0.3	0
8	1.2	0.9	0.6	0.4	0.4	0.3	0
9	1.5	1.1	0.6	0.4	0.4	0.3	0
10	1.7	1.3	0.6	0.4	0.5	0.3	0
11	1.9	1.4	0.6	0.4	0.5	0.3	0
12	2.1	1.6	0.6	0.4	0.6	0.3	0
13	2.3	1.8	0.7	0.5	0.6	0.3	0
14	2.5	2.0	0.7	0.5	0.6	0.3	0
15	2.9	2.1	0.7	0.5	0.6	0.4	0
16	3.0	2.2	0.8	0.6	0.6	0.4	0
17	3.2	2.3	0.8	0.6	0.7	0.4	0
18	3.4	2.5	0.8	0.6	0.7	0.4	0
19	3.6	2.7	0.8	0.7	0.7	0.4	0
20	3.8	2.9	0.9	0.7	0.7	0.5	0
21	3.9	3.0	0.9	0.7	0.7	0.5	0
22	4.1	3.1	0.9	0.7	0.8	0.5	0
23	4.3	3.2	1.0	0.8	0.8	0	0
24	4.4	3.4	1.0	0.8	0.8	0	0
25	4.6	3.5	1.1	0.8	0	0	0
26	4.7	3.6	1.2	0.8	0	0	0
27	4.9	3.7	1.4	0.8	0	0	0
28	5.0	3.9	1.5	0.9	0	0	0
29	5.2	4.1	1.6	0.9	0	0	0
30	5.3	4.2	1.7	1.0	0	0	0
31	5.5	4.4	1.8	1.0	0	0	0
32	5.7	4.6	1.9	1.0	0	0	0
33	5.9	4.7	2.0	1.1	0	0	0
34	6.1	4.9	2.1	1.1	0	0	0
35	6.2	5.1	2.2	1.1	0	0	0
36	6.4	5.2	2.3	1.1	0	0	0
37	6.6	5.3	2.4	1.2	0	0	0

*0 indicates no growth

TABLE VI

MEAN DIAMETERS IN CENTIMETERS OF COLONIES GROWN IN VARIOUS CONCENTRATIONS OF METHYLENE BLUE, AT A TEMPERATURE OF APPROXIMATELY 22° C.

Nutrient agar (product of Digestive Ferments Co.) pH 6.8							
Days after inocula-tion	Percentage concentration of dye						
	.00001	000025	.00005	.000075	.0001	.00025	.0005
1	0.3	0 3	0.3	0 3	0.2	0.4	0.3
2	0 3	0 3	0 3	0.3	0.2	0.4	0.3
3	0.3	0 3	0 3	0.3	0.2	0.4	0.3
4	0 5	0 4	0.3	0 3	0 2	0.4	0.3
5	0.7	0 5	0.3	0.3	0.2	0.4	0.3
6	0.9	0 6	0 4	0 4	0.2	0.4	0.3
7	1 1	0.8	0.5	0.4	0.3	0.4	0 3
8	1 4	1.0	0.5	0.4	0.3	0.5	0.4
9	1 6	1.1	0.6	0.4	0.4	0 5	0 4
10	1.8	1 3	0 7	0.5	0.4	0.5	0.4
11	2 0	1.5	0 9	0.6	0 5	0 5	0.4
12	2.2	1.7	1 0	0.7	0.5	0.5	0.5
13	2 4	1 8	1.1	0.8	0 6	0.5	0.5
14	2.6	2 0	1.2	0.8	0 6	0 5	0.5
15	2 8	2 1	1.3	0.8	0.6	0 5	0.5
16	2.9	2 3	1.5	0.9	0 7	0 6	0.5
17	3 1	2.5	1.6	0.9	0.7	0 6	0.6
18	3 4	2 7	1.7	0.9	0 7	0.6	0.6
19	3.6	2.8	1.8	1.0	0.8	0 6	0 6
20	3.8	3 0	1.9	1 0	0 8	0 6	0.7
21	4.0	3.2	2.0	1 0	0 8	0 7	0.7
22	4 1	3 4	2.1	1.1	0 9	0 7	0.7
23	4.4	3.5	2.2	1.1	0.9	0.7	0.8
24	4 6	3.6	2.4	1.2	1 0	0.7	0.8
25	4.7	3.8	2.4	1.3	1.0	0 7	0.8
26	4.9	4 0	2.6	1 3	1.1	0.8	0.8
27	5.1	4 2	2.7	1 4	1.1	0.8	0.8
28	5.2	4 3	2.9	1.6	1.2	0.8	0.8
29	5.4	4 4	3.0	1.7	1 2	0 9	0.8
30	5 6	4 6	3.2	1.8	1.3	0.9	0.9
31	5 7	4.7	3.3	1.8	1.3	0 9	0.9
32	5.9	4.9	3.5	1.9	1.4	0.9	0.9
33	6 1	5.1	3.6	2.1	1.5	1.0	0.9
34	6.3	5.2	3.8	2.2	1.6	1.0	0.9
35	6 5	5.3	4.0	2.3	1.7	1.1	0.9
36	6 7	5.4	4.1	2.4	1.8	1.1	0.9
37	6 8	5.5	4.2	2.5	1.9	1.2	0.9

TABLE VII

MEAN DIAMETERS IN CENTIMETERS OF COLONIES GROWN IN VARIOUS CONCENTRATIONS OF EOSINE B, AT A TEMPERATURE OF APPROXIMATELY 22° C.

Nutrient agar (product of Digestive Ferments Co.) pH 6.8							
Days after inoculation	Percentage concentration of dye						
	00001	000025	00005	.000075	.0001	.00025	.0005
1	0.3	0.2	0.3	0 3	0.5	0.4	0.5
2	0 3	0.2	0.3	0.3	0.5	0.4	0.5
3	0 3	0 2	0.3	0.3	0.5	0.4	0.5
4	0 4	0.4	0.4	0.6	0.7	0.4	0.7
5	0 6	0 5	0.6	0.7	0.9	0.6	0.7
6	0.7	0 6	0.7	0.8	1.0	0.7	0.8
7	0.9	0 9	0 9	1.0	1.2	0.9	1.0
8	1 2	1.2	1.2	1.3	1.4	1.1	1.3
9	1.3	1.3	1 3	1.4	1.6	1.3	1.4
10	1.5	1.5	1.5	1 6	1.8	1.5	1.6
11	1.6	1.7	1.7	1.8	2.0	1.8	1.8
12	1.9	1.9	1 9	2 0	2.2	2.0	2.1
13	2.1	2.1	2.1	2.2	2.4	2.2	2.3
14	2 3	2 3	2.3	2.5	2.6	2.4	2.5
15	2 5	2.5	2 5	2 6	2.9	2.6	2.7
16	2 7	2.7	2.7	2.9	3.1	2.8	2.9
17	2 9	2.9	2 9	3.1	3.3	3.1	3.1
18	3 1	3 1	3.2	3.2	3.5	3.2	3.2
19	3 3	3 3	3 3	3 4	3.6	3.4	3.2
20	3.5	3.4	3.5	3 5	3.8	3.5	3.2
21	3 6	3.6	3 7	3 7	3.9	3.7	0
22	3 8	3 8	3.8	3 9	4.1	3.8	0
23	3.9	4.0	4.0	4.0	4.2	3.9	0
24	4.1	4.2	4.2	4.2	4.3	4.1	0
25	4.2	4 4	4.3	4.3	4.5	4.3	0
26	4.4	4.5	4.5	4 5	4.6	4.5	0
27	4.6	4.7	4.7	4.6	4.8	4 6	0
28	4.7	4 8	4 8	4.8	4.9	4.8	0
29	4.9	5.0	5.0	5.0	5.1	5.0	0
30	5 1	5 2	5.2	5.1	5.2	5.1	0
31	5.3	5.3	5.3	5.3	5.4	5.3	0
32	5.4	5.5	5.5	5.5	5.5	5.5	0
33	5.6	5.7	5.7	5.6	5.7	5.5	0
34	5.7	5.8	5.8	5.8	5.8	0	0
35	5.9	6.0	6.0	5.9	6.0	0	0
36	6.0	6.1	6.1	6.1	6.1	0	0
37	6.2	6.3	6.3	6.2	6.2	0	0

The same microscopical features were also observed in the case of methylene blue, but not quite so outstanding. The rates of growth for both crystal violet and methylene blue, as seen in figs. 11 and 13 respectively, showed a decrease with a more marked sudden drop in the case of crystal violet. These may perhaps be better illustrated in figs. 12 and 14, both being corrected for the inoculum so that the curves represent the total growth at each concentration of the dye for the period denoted. The growth on crystal violet showed a sudden decrease which comes to zero at a concentration of .0005. In the case of methylene blue, however, the decrease was gradual, and the curve may be said to be practically straight.

These results are therefore in accord with the genesistasis beliefs of Churchman or the "bacteriostatic properties," and may be further substantiated by the observation that the inoculum of the crystal violet medium of concentration .0005, which had shown no growth over a period of four months, was transferred to fresh medium and developed into a normal and healthy culture.

A phenomenon which is difficult to explain in the light of this work is the fact that in concentrations of .0001, .00025 and .0005, where there had been very little or no growth, a renewed activity occurred approximately five months after inoculation, in flasks where there had been a rather large amount of agar which had not dried out. A possible explanation may be perhaps that the organism had become accustomed to the dye and, there being enough nutrient in the medium, it began to grow, developing hyphae from the chlamydospores which had been dormant. A microscopic examination of these renewed viability cultures showed many chlamydospores (round) and thick-walled hyphae still present. A chemical interpretation of this phenomenon has as yet not been postulated and will perhaps require much more work and a better understanding of the reaction.

In the case of eosine B, growth was normal on all concentrations up to the nineteenth day, as seen in table VII, when growth actually ceased in the medium of the highest concentration of the dye (.0005). This was followed by a cessation in growth on the thirty-fourth day for the concentration .00025. This phenomenon has been noticed and reported in previous papers by the

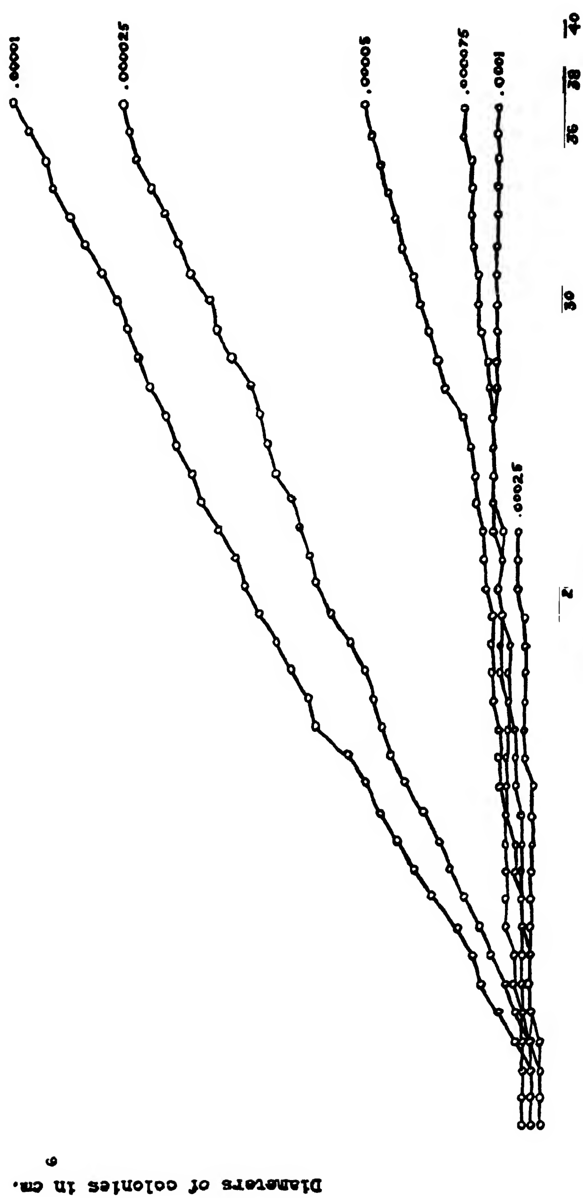


Fig. Rate of at co ame pH on nutı with ɔus co. of crystal violet.

author for eosine-methylene-blue agar where the mycelium had taken on a pink to blue color and ceased growing. These cultures when transplanted to fresh agar grew just as luxuriantly as

though they had never been affected. What may have happened is that the dye, being acid, may have been absorbed by the fungus,

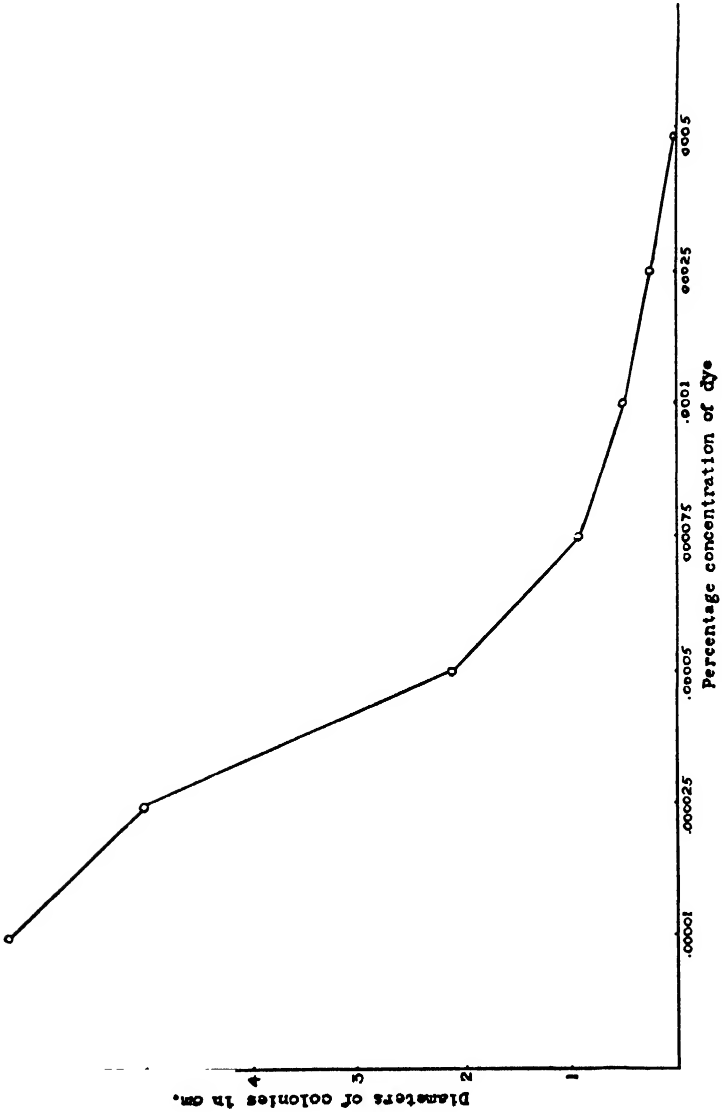


Fig.

as evidenced by the color of the mycelium, and was strong enough to counteract the metabolic activities of the cell. It would seem

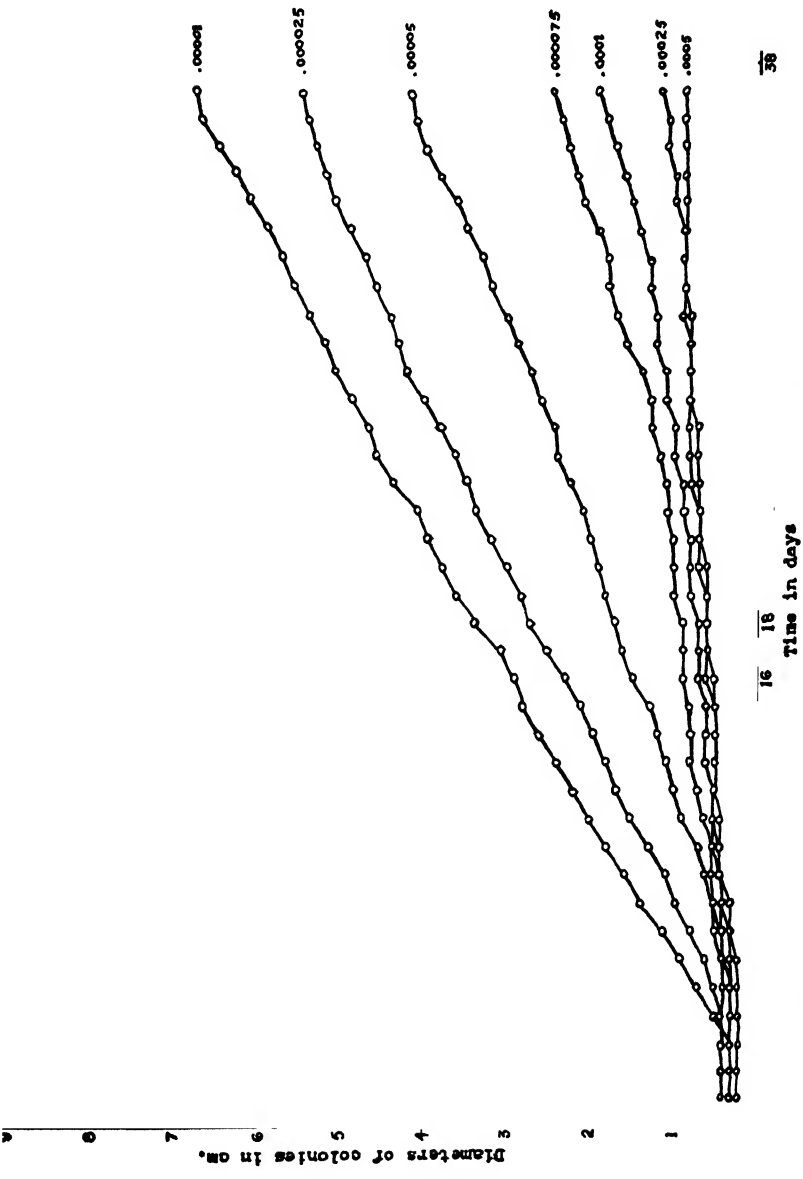


Fig. 1 Rate of growth a‹ and same pH on nutrient ‹r with concentratior of methylene blue.

from a study of the pH of the medium, which changes from a slightly acid to alkaline in normal growth, that this could be detected. However, the medium was already covered with

Percen[t] conce[ntration] of dye

.00007 .0001

Diameters of colonies in cm.

Fig. ... temperatur[e] ... [an]d same pH ... nutrie[nt] ... [methy]lene blue.

sufficient growth to cause an alkaline condition, so that no direct evidence could be obtained from that direction. There are no definite facts to uphold this belief, and the statement should be considered more as a conjecture for the present. There have

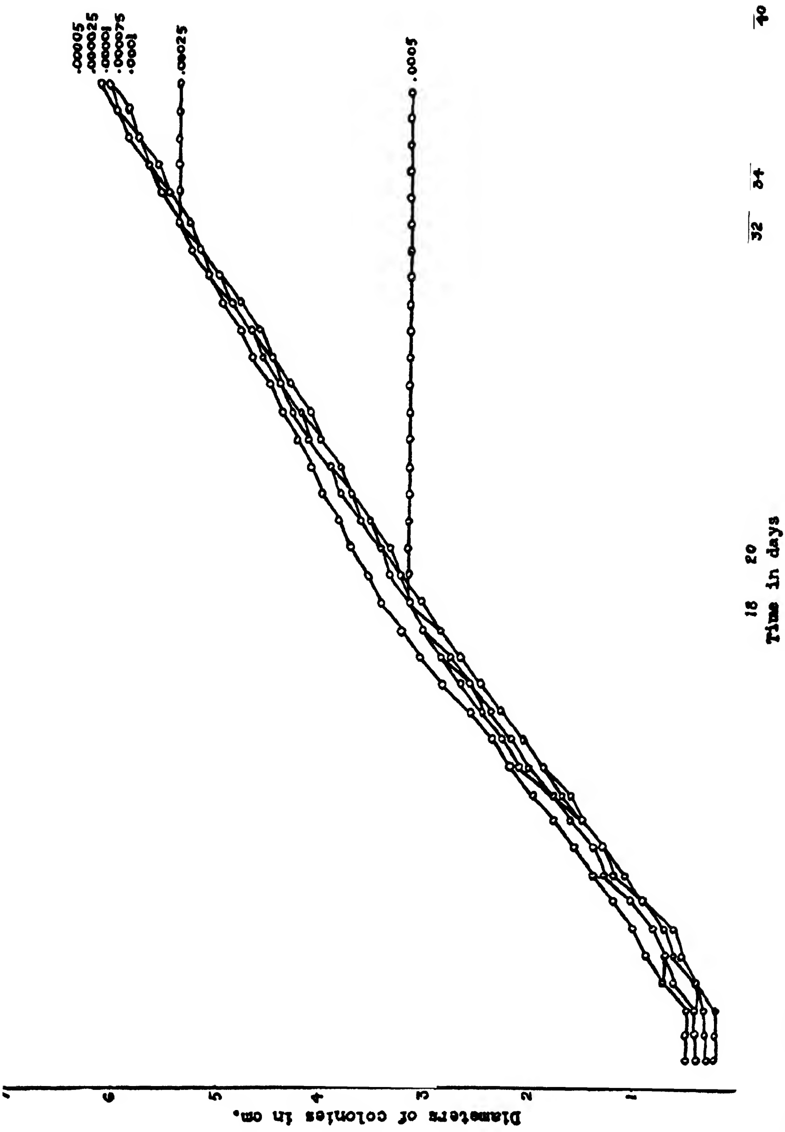


Fig. 15. Rate of nu a and same pH with various c of eosine B.

been many theories proposed, but none have had any final acceptance.

The action of eosine B on the organism is illustrated in figs. 15–16. The former shows the rate of growth of the cultures on

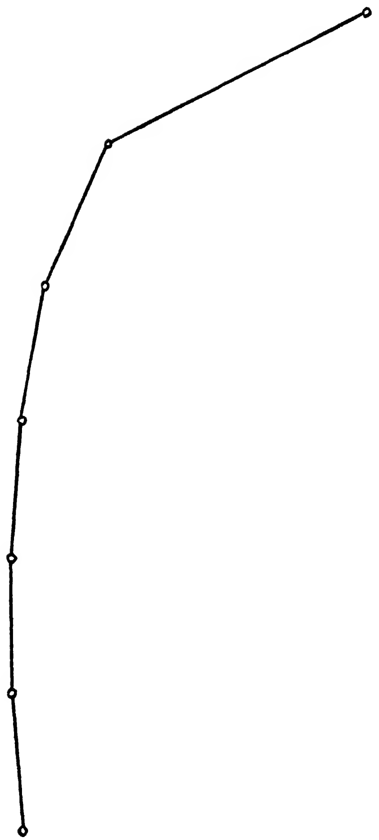


Fig. Perc ... 075 ... concentration of dye
temper ... d same pH on nutrient
sine B.

various concentrations of dye. Growth on the concentration .0005 was inhibited on the nineteenth day, and that on the concentration .00025, on the thirty-fourth day. Fig. 16 represents the maximal points of growth corrected for the inoculum. The inhibition of growth is clearly distinguishable here.

A further phenomenon is noted here, not because it was absolutely specific for this experiment but because it had appeared most frequently on crystal violet media of concentrations .0001 and .00025. This is the formation of crystals in the media, appearing to emanate from the growing zone or peripheral region of the colony and found in conditions which have not been very favorable towards growth. They have occurred on beef extract agar of pH 7.2, 7.0, and 6.8. No crystals of this sort were found on media where there was no growth or where growth was very luxuriant. They appear to resemble very closely those of ammonium magnesium phosphate ($NH_4MgPO_4.6\ H_2O$) as was reported also by Scudder ('26). They were insoluble in cold water, completely and immediately soluble in hydrochloric acid, and were reprecipitated with sodium hydroxide, tests which are applied to crystals of the above composition. They were apparently the result of fungal activity, and Scudder has associated this condition with bacteria which "do not ferment the ordinary carbohydrates and intensify the alkalinity of the medium rapidly," a fact which has been clearly demonstrated in the carbohydrate reactions carried out in this paper.

Animal Inoculations

From time to time papers appear in the literature pointing out that some particular organism which had been kept in culture over a long period and then inoculated in experimental animals, had retained its pathogenic properties. On the other hand, it is quite well known that this property may be lost on subculturing. It is also known that by growth on certain media at a specific temperature, toxicity may be retained over a long time. It has also been found that certain microorganisms may be made to regain lost toxic powers by repeated inoculations.

In order to determine whether *E. capsulatus* had undergone any such changes since it was isolated in September, 1928, and kept in culture at different temperatures, on different media, and at various hydrogen-ion concentrations, several animals were inoculated with a twelve-day-old suspension of the organism in 10-cc. physiological saline solution. The culture was stirred up thoroughly with a sterile needle to eliminate the clumps.

The animals and inoculations were as follows:

Rabbits: Two females—intracerebral (0.2 cc.) and intravenous (0.5 cc.). Two males—subcutaneous (2 cc.) and intratesticular (1 cc.).

Guinea-pigs: Two, one male and one female—intracerebral (0.2 cc.). Two males—subcutaneous (1.5 cc.) and intratesticular (1 cc.).

Mice: Two, one male and one female—intracerebral (0.2 cc.). One male—subcutaneous (1 cc.) and intratesticular (0.5 cc.).

The results of these inoculations were that one of the rabbits receiving a subcutaneous and intratesticular inoculation died twenty-three days later. Autopsy revealed no infection or lesion, except an intestinal obstruction. Three mice, healthy, with no loss of weight or appetite, were killed fifty days after inoculation. The organs were completely negative. Cultures of the heart's blood also negative. The rabbits and guinea-pig were healthy, with no loss of weight, three months after inoculation. The remaining mouse, with an intracerebral injection, died sixty-two days after inoculation as a result of pneumonia. Autopsy showed no complication of the other organs. Cultures of infected lung tissue and brain negative for *E. capsulatus*, the lung in a hemorrhagic condition.

It may be concluded, therefore, that the organism had lost its power to infect after four years' growth on artificial substrates. That it failed to produce a toxic action in an animal may be attributed to the changed environment and habitat of the fungus. It has been pointed out previously that the optimum temperature has been reduced from 37.5° C. to approximately 25° C. In addition, experimental data has shown that growth at the former temperature was very slow and slight, with complete cessation and death after a short time. It is very possible that the organism was killed here, as in the *in vitro* experiments, as a result of the body temperature of the experimental animals. A further point of interest is the condition of aerobiosis as found here. When freshly isolated, the yeast-cells of *E. capsulatus* or *E. dermatitidis* are able to live in a condition of facultative aerobiosis, that is, with or without oxygen, favoring the presence of air. With continued cultivation on artificial media, the organism

adapts itself to a saprophytic form of life and as a result becomes a strict aerobe, requiring oxygen for its existence. This change to strict aerobiosis is an important factor, since, by inoculation in the animal body, the organism is forced into an aerobic condition which it cannot endure and, as probably happened here, it is killed for lack of oxygen.

There are probably several other factors which may account for this failure of the organism to cause infection, but what has been said above accounts for the chief difficulties.

Summary and Conclusions

1. A review of the case histories from which the organisms *Endomyces capsulatus*, *E. capsulatus* var. *isabellinus*, *E. dermatitidis*, and the Austrian fungus were isolated are given.

2. A study of the organism shows that it has two life cycles: one in the parasitized host as a budding yeast-cell with the chromatin material spread throughout the cell; and the other as a perfect Ascomycete, reproducing by the development of 8-spored asci resulting from a sexual act which may be either hetero- or isogamy or have become reduced to parthenogamy.

3. No definite form of mitosis is demonstrable; instead conditions similar to those described as amitosis are recorded.

4. Cellular contents, as volutin, glycogen, vacuoles, chondriosomes, and fat or lipoidal substances, are demonstrated in *E. capsulatus* by various methods.

5. The cultural work is described in detail and includes descriptions of the organism on 29 different media, showing that hydrogen-ion concentration may influence growth as expressed by thin hyphae and numerous conidia on acid media and thick-walled, shorter cells on alkaline media.

6. After four years of subculturing an optimum temperature of 25° C. is determined for the organism, with no growth occurring above 37° C. or below 8.0° C.

7. An optimum pH of 7.4 is determined for *E. capsulatus*, with no growth occurring at a pH greater than 9.3 or less than 3.3.

8. The carbohydrates used in this work require a variation in time for the production of alkalinity. No acid or gas is produced. Hydrogen-ion measurements show a decrease from

the initial pH of 6.8 to an end point of approximately 8.1, which is accounted for by the production of ammonia and probably hexone bases.

9. Under proper conditions, indol and skatol reactions are present.

10. In the yeast form *E. capsulatus* may show facultative anaerobiosis, but growth on an artificial substrate converts the organism into a strict aerobe.

11. Nitrate reduction and hydrogen sulphide production yield indefinite results.

12. Gelatine is slowly liquefied after 30 days.

13. Light, either white or red, has no effect on the organism as compared with that of dark or diffuse daylight and total darkness.

14. Several dyes, orange G, Sudan III, alizarin, neutral red, safranine A, light green SF, basic fuchsin, aniline blue, phenol red, and haematoxylin, in concentrations of .00001, .000025, .00005, .000075, .0001, .00025, .0005, when incorporated in an agar medium have no effect on growth. Crystal violet and methylene blue in the same concentrations show a gradual decrease in growth, with complete cessation at a concentration of .0005 for crystal violet. Crystal violet showed a reduction in the number of nuclear divisions, sexual fusions, and production of asci, with an accompanying enlargement of the cells, development of thick walls, secretion of granular material in the cytoplasm, conditions associated with the formation of chlamydospores under unfavorable conditions. Eosine B has an effect on growth in high concentrations.

15. Animal inoculations for pathogenicity were negative after subculturing for a period of approximately four years.

Acknowledgements

The author wishes to thank most sincerely Dr. Carroll W. Dodge, Professor of Botany in the Henry Shaw School of Botany, under whose most able and critical direction this work was carried out; Dr. George T. Moore, Director of the Missouri Botanical Garden, whose abundant generosities made possible many of the facilities necessary in this paper; Dr. Edward C.

Jeffrey, Professor of Botany at Harvard University, in whose laboratory the details of the cytological technique were applied; and Dr. Edmund V. Cowdry, Professor of Cytology in the School of Medicine of Washington University, through whose kindness and efforts the animal inoculations were carried out.

Bibliography

Atkinson, G. F. ('15). Phylogeny and relationships in the Ascomycetes. Mo. Bot. Gard., Ann. **2**: 315–376. 1915.

Bagchee, K. ('25). Cytology of the Ascomycetes. Pustularia bolarioides. Ann. Bot. **39**: 217–266. 1925.

Blackman, V. H., and H. C. I. Fraser ('05). Fertilization in Sphaerotheca. *Ibid.* **19**: 567–569. 1905.

Brooks, F. T. ('10). The development of Gnomonia erythrostoma Pers. *Ibid.* **24**: 585–605. 1910.

Brown, W. H. ('10). The development of the ascocarp of Leotia. Bot. Gaz. **50**: 443–459. 1910.

————, ('11). The development of the ascocarp of Lachnea scutellata. *Ibid.* **52**: 275–305. 1911.

Carruthers, D. ('11). Contributions to the cytology of Helvella crispa. Ann. Bot. **25**: 243–252. 1911.

Chamberlain, C. J. ('32). Methods in plant histology. 5th rev. ed. 416 pp. Univ. of Chicago Press. 1932.

Chiari, H. ('30). Zur Pathologie und Histologie der generalisierten Torulose (Blastomykose). Arch. f. Derm. u. Syphil. **162**: 422–441. 1930.

Churchman, J. W. ('12). The selective bactericidal action of gentian violet. Jour. Exp. Med. **16**: 221–248. 1912.

————, ('20). The cause of the parallelism between the Gram reaction and the gentian violet reaction. Soc. Exp. Biol. & Med., Proc. **18**: 17–18. 1920.

————, ('20a). The isolation of gentian positive individuals from a gentian negative organism (B. coli). *Ibid.* 19. 1920.

('20b). Relation of the gentian violet reaction to dilution of implanted suspension. *Ibid.* 20. 1920.

———, ('20c). The effect of repeated inoculations of gentian violet agar with gentian positive organisms. *Ibid.* 20–21. 1920.

———, ('20d). The selective action of gentian violet in relation to chemotherapy. *Ibid.* 21–22. 1920.

———, ('20e). The communal activity of bacteria. *Ibid.* 22–23. 1920.

———, ('21). Further studies on the behavior of bacteria toward gentian violet. Jour. Exp. Med. **33**: 569–582. 1921.

–, and M. C. Kahn ('21). Communal activity of bacteria. *Ibid.* 583–592. 1921.

Clark, E. B. ('27). Effect of gentian violet and mercurochrome on Endomyces albicans, with special reference to the mycelial form. Jour. Infect. Dis. **40**: 423–424. 1927.

Claussen, P. ('06). Über neuere Arbeiten zur Entwicklungsgeschichte der Ascomyceten. Ber. d. Deut. Bot. Ges. **24**: (11)–(38). 1906.

Concetti, L. ('00). Biologie et pathogénie du muguet. Arch. Méd. Enf. **3**: 479, 517–541, 590–605. 1900.

Cowdry, N. H. ('17). A comparison of mitochondria in plant and animal cells. Biol. Bull. **33**: 196–228. 1917.

Dangeard, P. A. ('93). Sur la structure histologique des levures et leur développement. Compt. Rend. Acad. Sci. **117**: 68–70. 1893.

————, ('94). Recherches sur la reproduction sexuelle des champignons. Le Botaniste **3**: 221–281. 1894.

————, ('94a). La structure des levures et leur développement. *Ibid.* 282–286. 1894.

————, ('94b). La reproduction sexuelle des Ascomycètes. *Ibid.* **4**: 21–58. 1894.

————, ('97). Second mémoire sur la reproduction sexuelle des Ascomycètes. *Ibid.* **5**: 245–284. 1897.

————, ('04–'06). Recherches sur le développement du périthèce chez les Ascomycètes. *Ibid.* **9**: 59–303. 1904–1906.

————, ('07). *Ibid.* II. L'origine du périthèce chez les Ascomycètes. *Ibid.* **10**: 1–385. 1907.

Devereux, E. D., and F. W. Tanner ('27). Observations on the growth of yeasts in pure nutrient solutions. Jour. Bact. **14**: 317–333. 1927.

Faber, H. K., and L. B. Dickey ('25). The treatment of thrush with gentian violet. Am. Med. Assoc., Jour. **85**: 900–901. 1925.

Farley, D. L. ('20). The use of gentian violet as a restrainer in the isolation of pathogenic moulds. Arch. Derm. & Syphil. **2**: 459–465. 1920.

————, ('20a). The cultivation of Epidermophyton inguinale. *Ibid.* 466–469. 1920.

Faull, J. H. ('05). Development of the ascus and spore formation in Ascomycetes. Boston Soc. Nat. Hist., Proc. **32**: 77–114. 1905.

Fellers, C. R., and R. W. Clough ('25). Indol and skatol determination in bacterial cultures. Jour. Bact. **10**: 105–133. 1925.

Fineman, B. C. ('21). A study of the thrush parasite. Jour. Infect. Dis. **28**: 185–200. 1921.

Fraser, H. C. I., and J. W. St. John Brooks ('09). Further studies on the cytology of the ascus. Ann. Bot. **23**: 537–549. 1909.

————, and E. J. Welsford ('08). Further contributions to the cytology of the Ascomycetes. *Ibid.* **22**: 465–477. 1908.

Fuhrmann, F. ('06). Die Kernteilung von Saccharomyces ellipsoideus I. Hansen bei der Sprossbildung. Centralbl. f. Bakt. II, **15**: 769–777. 1906.

Gaümann, E. A., and C. W. Dodge ('28). Comparative morphology of fungi. 701 pp. McGraw Hill Book Co. New York. 1928.

Gnezda, J. ('99). Sur les réactions nouvelles des indoliques et des corps albuminoides. Compt. Rend. Acad. Sci. **128**: 1584–1587. 1899.

Goré, S. N. ('21). The cotton wool plug test for indole. Indian Jour. Med. Res. **8**: 505–507. 1921.

Greenbaum, S. S., and J. V. Klauder ('22). Yeast infections of the skin: Report of cases and of studies on the cutaneous yeasts. Arch. Derm. & Syphil. **5**: 332–344. 1922.

Guilliermond, A. ('03). Recherches cytologiques sur les levures. Rev. Gén. Bot. **15**: 49–66, 104–124, 166–185. 1903.

——, ('03a). Contribution à l'étude de l'épiplasme des Ascomycètes et recherches sur les corpuscules métachromatiques des champignons. Ann. Myc. **1**: 201–215. 1903.

——, ('04). Sur le noyau de la levure. *Ibid.* **2**: 184–189. 1904.

——, ('04a). Contribution à l'étude de la formation des asques et de l'épiplasme des Ascomycètes. Rev. Gén. Bot. **16**: 49–65. 1904.

——, ('04b). Recherches sur la karyokinèse chez les Ascomycètes. *Ibid.* 129–143. 1904.

——, ('05). Recherches sur la germination des spores et la conjugaison chez les levures. *Ibid.* **17**: 337–376. 1905.

————, ('05a). La morphologie et la cytologie des levures. Inst. Pasteur, Bull. **3**: 177–184, 225–235. 1905.

————, ('05b). Remarques sur la karyokinèse des Ascomycètes. Ann. Myc. **3**: 343–361. 1905.

————, ('07). À propos de l'origine des levures. *Ibid.* **5**: 49–69. 1907.

————, ('07a). La cytologie des bactéries. Inst. Pasteur, Bull. **5**: 273–283. 1907.

————, ('08). Contribution à l'étude cytologique des bacilles endosporés. Arch. f. Protistk. **12**: 9–43. 1908.

————, ('08a). La question de la sexualité chez les Ascomycètes. Rev. Gén. Bot. **20**: 32–39, 85–89, 111–120, 178–182, 298–305, 332–344, 364–378. 1908.

————, ('09). Sur la phylogenèse des levures. Compt. Rend. Soc. Biol. **66**: 998–1000. 1909.

————, ('09a). Observations sur la cytologie d'un bacille. *Ibid.* **67**: 102–103. 1909.

————, ('09b). Recherches cytologiques et taxonomiques sur les Endomycétées. Rev. Gén. Bot. **21**: 353–391, 401–419. 1909.

————, ('10). La sexualité chez les champignons. Bull. Sci. France et Belg. **44**: 109–196. 1910.

————, ('10a). Remarques critiques sur différentes publications sur la cytologie des levures et quelques observations sur la structure de ces champignons. Centralbl. f. Bakt. II, **26**: 577–589. 1910.

————, ('10b). Remarques sur le développement de l'Endomyces fibuliger (Lindner). Compt. Rend. Soc. Biol. **68**: 318–320. 1910.

————, ('11). Apercu sur l'évolution nucléaire des Ascomycètes. Rev. Gén. Bot. **23**: 89–120. 1911.

————, ('11a). Sur un exemple de copulation hétérogamique observé chez une levure. Compt. Rend. Soc. Biol. **70**: 442–444. 1911.

————, ('11b). Sur les mitochondries des cellules végétales. *Ibid.* **153**: 199–201. 1911.

————, ('12). Nouvelles observations sur la sexualité des levures. Arch. f. Protistk. **28**: 52–77. 1912.

————, ('13). Les progrès de la cytologie des champignons. Prog. Rei Bot. **4**: 389–542. 1913.

————, ('14). Monographie des levures rapportées d'Afrique occidentale. Ann. Sci. Nat. Bot. **19**: 1–32. 1914.

————, ('17). Sur la division nucléaire des levures. Ann. Inst. Pasteur **31**: 107–113. 1917.

————, ('19). Sur une nouvelle levure à copulation hétérogamique. Compt. Rend. Soc. Biol. Paris **82**: 466–470. 1919.

————, ('20). Zygosaccharomyces Pastori, nouvelle espèce de levure à copulation hétérogamique. Soc. Myc. France, Bull. **36**: 203–211. 1920.

————, et G. Péju ('19). Sur un nouveau champignon présentant des caractères intermédiaires entre les levures et les Endomyces. Compt. Rend. Soc. Biol. **82**: 1343–1346. 1919.

————, ('20). Une nouvelle espèce de levure du genre Debaryomyces, D. Klockeri, n. sp. Soc. Myc. France, Bull. **36**: 164–171. 1920.

————, ('21). Une nouvelle espèce de levure du genre Debaryomyces, D. Nadsonii, n. sp. *Ibid.* **37**: 35–38. 1921.

————, G. Mangenot, et L. Plantefol ('33). Traité de cytologie végétale. 1195 pp. Librairie e Le François. Paris, 1933.

Hansen, E. ('04). Grundlinien zur Systematik der Saccharomyceten. Centralbl. f. Bakt. **12**: 529–538. 1904.

Harper, R. A. ('96). Über das Verhalten der Kerne bei der Fruchtentwickelung einiger Ascomyceten. Jahrb. f. wiss. Bot. **29**: 655–685. 1896.

————, ('97). Kernteilung und freie Zellbindung im Ascus. *Ibid.* **30**: 249–284. 1897.

————, ('99). Cell-division in sporangia and asci. Ann. Bot. **13**: 467–525. 1899.

————, ('00). Sexual reproduction in Pyronema confluens and the morphology of the ascocarp. *Ibid.* **14**: 321–400. 1900.

Holman, W. L., and F. L. Gonzales ('23). A test for indol based on the oxalic acid reaction of Gnezda. Jour. Bact. **8**: 577–583. 1923.

Janssens, A. ('02). À propos du noyau de la levure. La Cellule **20**: 335–349. 1902.

————, et A. Leblanc ('98). Recherches cytologiques sur la cellule de levure. *Ibid.* **14**: 201–243. 1898.

Kater, J. McA. ('27). Cytology of Saccharomyces cerviciae, with especial reference to nuclear division. Biol. Bull. **52**: 436–448. 1927.

————, ('28). Note on the structure of a Monilia isolated from a case of psoriasis. Univ. Calif. Publ. Bot. **14**: 301–306. 1928.

Kohl, F. G. ('07). Über das Glykogen und einige Erscheinungen bei der Sporulation der Hefe. Ber. d. Deut. Bot. Ges. **25**: 74–85. 1907.

Koser, S. A., and R. H. Galt ('26). The oxalic acid test for indol. Jour. Bact. **11**: 293–303. 1926.

Krumwiede, C., und J. S. Pratt ('13). Dahlia-Agar als Unterschiedsungmittel zwischen Cholera und anderen Vibrionen. Centralbl. f. Bakt. Orig. **68**: 562–566. 1913.

Kulp, W. L., and L. F. Rettger ('24). Comparative study of Lactobacillus acidophilus and Lactobacillus bulgaricus. Jour. Bact. **9**: 357–394. 1924.

Lewis, M. R. ('30). Effect of dyes on the virus of chicken tumor. Amer. Jour. Hyg. **12**: 288–296. 1930.

Maire, R. ('04). Sur les divisions nucléaires dans l'asque de la morille et de quelques autres Ascomycètes. Compt. Rend. Soc. Biol. **56**: 822–824. 1904.

————, ('05). Recherches cytologiques sur quelques Ascomycètes. Ann. Myc. **3**: 123–154. 1905.

Mallinckrodt-Haupt, A. St. von ('32). Der Wert der pH-Messung bei Pilzkulturen. Zentralbl. f. Bakt. Orig. **125**: 368–374. 1932.

Malone, R. H., and S. N. Goré ('21). The relation of indole in bacterial culture. Indian Jour. Med. Res. **8**: 490–504. 1921.

Mangenot, G. ('19). Sur la formation des asques chez Endomyces Lindneri (Saïto). Compt. Rend. Soc. Biol. **82:** 477–479. 1919.

Marantonio, R. ('93). Contributo alla biologia del fungo del mughetto. Ann. Ist. Ig. Roma **3:** 199–223. 1893.

Meyer, R. ('28). Über den Einfluss der Temperatur auf den Wachstumablauf bei Pilzen. Biochem. Zeitschr. **198:** 463–477. 1928.

Milochevitch, S. ('29). Das Wachstum und die Wachstumformen des Soorpilzes auf verschiedenen Nährboden besonders auf solchen die mit Extrakten aus Körperorgane Hergestellt wurden. Zentralbl. f. Bakt. Orig. **114:** 174–186. 1929.

Moore, M. ('32). Coccidioidal granuloma: A classification of the causative agent, Coccidioides immitis. Mo. Bot. Gard., Ann. **19:** 397–428. 1932.

————, ('33). Blastomycosis: Report of a case with a study of an etiologic factor and a classification of the organism. *Ibid.* **20:** 79–117. 1933.

[————], MacBryde, C. M., and E. J. Thompson ('33). Meningitis and dermatitis caused by a new variety of blastomycete (endomycete). Arch. of Derm. & Syphil. **27:** 49–69. 1933.

Morelli, G. ('09). Ueber ein neues Verfahren zum Nachweis von Indol auf Nährsubstraten. Centralbl. f. Bakt. Orig. **50:** 413–415. 1909.

Ota, M. ('24). Beiträge zur Morphologie, Biologie und Systematik der pathogenen, asporogenen Sprosspilze. Dermat. Wochenschr. **78:** 216–237, 260–265. 1924.

Petroff, S. A. ('15). A new and rapid method for the isolation and cultivation of tubercle bacilli directly from sputum and feces. Jour. Exp. Med. **21:** 38–42. 1915.

Pittaluga, G. ('08). Sobre un nuevo metodo para la investigacion del indol en la practica bacteriologica. [Abs. in Bull. l'Inst. Pasteur **6:** 578–579. 1908.]

Rewbridge, A. G., C. W. Dodge, and T. T. Ayers ('29). A case of meningitis due to Endomyces capsulatus (new species). Amer. Jour. Path. **5:** 349–364. 1929.

Salkowski, E. ('83). Zur Kenntniss der Eiweissfäulnis 1: Ueber die Bildung des Indols und Skatols, nach gemeinschaftlich mit H. Salkowski in münster i/w angestellten Versuchen. Zeitschr. Physiol. Chem. **8:** 416–466. 1883.

Sanderson, E. S., and D. C. Smith ('27). The effect of gentian violet on the organism of blastomycotic infection. Arch. Derm. & Syphil. **16:** 153–155. 1927.

Sasaki, T. ('10). Über eine neue empfindliche Skatolreaktion. Biochem. Zeitschr. **23:** 402–403. 1910.

Scudder, S. A. ('26). Crystal formation in bacterial cultures. Jour. Bact. **11:** 90–91. 1926.

Shrewsbury, J. F. D. ('30). The genus Willia. Jour. Path. & Bact. **33:** 393–416. 1930.

Smith, T. ('99). The relation of dextrose to the production of toxin in bouillon cultures of the diphtheria bacillus. Jour. Exp. Med. **4:** 373–397. 1899.

Spring, D. ('29). Comparison of seven strains of organisms causing blastomycoses in man. Jour. Infect. Dis. **44:** 169–185. 1929.

Stearn, E. W., and A. E. Stearn ('23). The mechanical behavior of dyes especially gentian violet, in bacteriological media. Jour. Bact. **8:** 567–572. 1923.

————, ————,('29). Comparative inhibiting effect of gentian violet and mercurochrome on the growth of certain fungi. Jour. Lab. & Clin. Med. **14:** 1057–1060. 1929.

Steensma, F. A. ('06). Über Farbenreaktionen der Eiweisskörper, des Indols und

des Skatols mit aromatischen Aldehyden und Nitriten. Zeitschr. physiol. Chem. **47**: 25–27. 1906.

———, ('06a). Über den Nachweis von Indol und die Bildung von Indol vortäuschenden Stoffen in Bakterienkulturen. Centralbl. f. Bakt. Orig. **41**: 295–298. 1906.

Stendel, H., und E. Peiser ('19). Über die Hefenucleinsäure. Zeitschr. physiol. Chem. **108**: 42–49. 1919.

Swellengrebel, M. ('05). Sur la division nucléaire de la levure pressée. Ann. Inst. Pasteur **19**: 503–515. 1905.

Talice, R. ('30). Sur la filamentisation des Monilia. Ann. Parasitol. Hum. Comp. **8**: 394–410. 1930.

Thomas, P. ('21). Recherches sur les protéiques de la levure. Ann. Inst. Pasteur **35**: 43–95. 1921.

Urbach, E., und F. Zach ('30). Generalisierte Torulose (europäische Blastomykose). Eine klinisch-botanische Studie. Arch. f. Derm. u. Syphil. **162**: 401–421. 1930.

Wager, H. ('98). The nucleus of the yeast-plant. Ann. Bot. **12**: 499–544. 1898.

———, and A. Peniston ('10). Cytological observations on the yeast-plant. *Ibid.* **24**: 45–84. 1910.

Watanabe, J. ('32). The action of sugar on amino acid. I. The reaction in alkaline medium. Jour. Biochem. **16**: 163–190. 1932.

Wetmore, R. H. ('32). The use of celloidin in botanical technic. Stain Technol. **7**: 37–62. 1932.

Zikes, H. ('22). Beitrag zum Volutinvorkommen in Pilzen. Centralbl. f. Bakt. II, **57**: 21–45. 1922.

Zinsser, H. ('29). A textbook of bacteriology. 1053 pp. 6th ed. D. Appleton and Co., New York. 1929.

Zipfel, H. ('12). Zur Kenntnis der Indolreaktion. Centralbl. f. Bakt. Orig. **64**: 65–80. 1912.

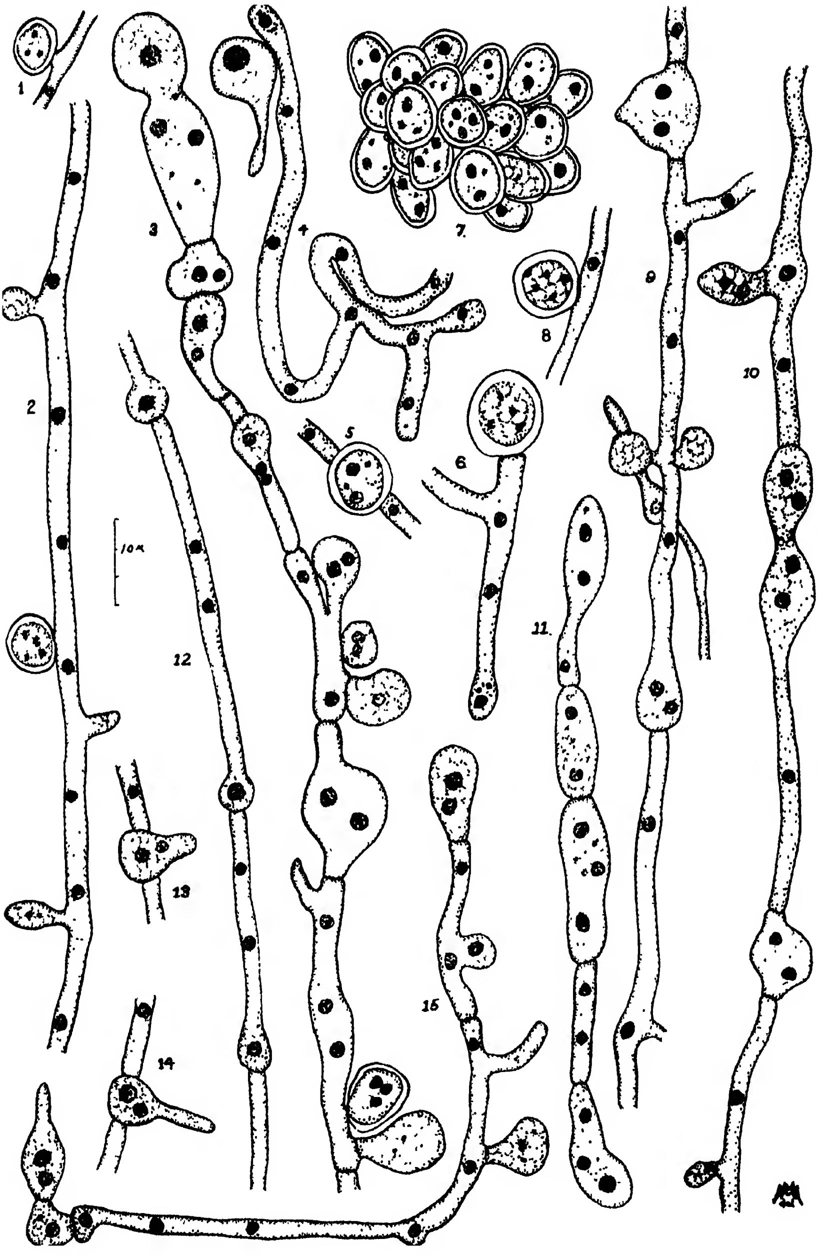
Zoller, H. F. ('20). Influence of hydrogen ion concentration upon the volatility of indole from aqueous solution. Jour. Biol. Chem. **41**: 37–44. 1920.

Explanation of Plate

PLATE 16

All figures drawn at a magnification of × 1440 with the aid of a camera lucida.

Fig. 1. Thick-walled cell on glycerine agar.
Fig. 2. Young mycelium.
Fig. 3. Mature mycelium with conidia, terminal hypnospores, and oidia.
Fig. 4. Mycelium on blood agar.
Fig. 5. Intercalary chlamydospore.
Fig. 6. Terminal hypnospore.
Fig. 7. Group of thick-walled cells on bacto-peptone plus glycerine.
Fig. 8. Thick-walled cell on corn-meal agar.
Fig. 9. Mycelium with racquet hyphae, conidia, and intercalary chlamydospore.
Fig. 10. Mycelium grown on calcium carbonate medium.
Fig. 11. Mycelium on glycerine agar.
Fig. 12. Racquet mycelium on Sabouraud's agar.
Fig. 13. Endo-chlamydospore.
Fig. 14. Growth of fig. 13.
Fig. 15. Mycelium with conidia, young developing hyphal branch, and hypnospores on beef extract agar.



MOORE—ENDOMYCES CAPSULATUS

Explanation of Plate

PLATE 17

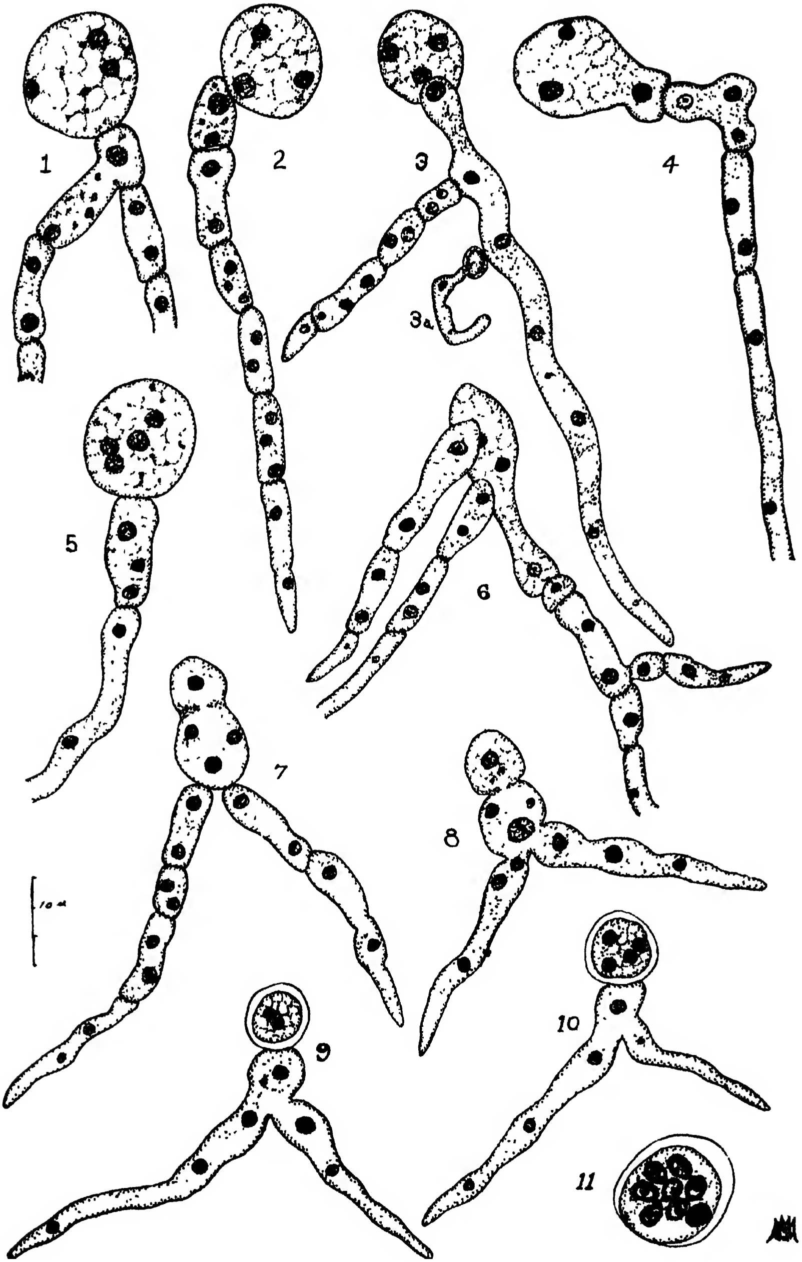
All drawings made from a hanging-drop culture of bacto-peptone plus glycerine, with the aid of a camera lucida at × 1440.

Figs. 1–5. Chlamydospores and young hyphae.

Fig. 3a. Young germinating spore.

Fig. 6. Group of germinating spores.

Figs. 7–11. Developmental series observed over a period of 3 days with the final formation of an ascus with 8 spores (fig. 11). Condition analogous to the Stoppel form of fertilization.



MOORE—ENDOMYCES CAPSULATUS

Explanation of Plate

PLATE 18

All figures drawn with the aid of a camera lucida at a magnification of × 1440.

Fig. 1. Hypha on malt extract agar showing chlamydospores.

Fig. 2. Terminal chlamydospore or ascogonial cell.

Fig. 3. Hyphal termination.

Figs. 4–5. Yeast-like cells with thick walls, grown on beef extract plus blood serum agar.

Fig. 6. Hypha with pyriform conidia, lateral chlamydospores on wort agar.

Fig. 7. Hyphae showing an abundance of conidia on Raulin's solution agar.

Fig. 8. Mycelium on wort agar.

Fig. 9. A spore which has germinated and produced a large lateral cell.

Fig. 10. Racquet mycelium with a large pyriform conidium.

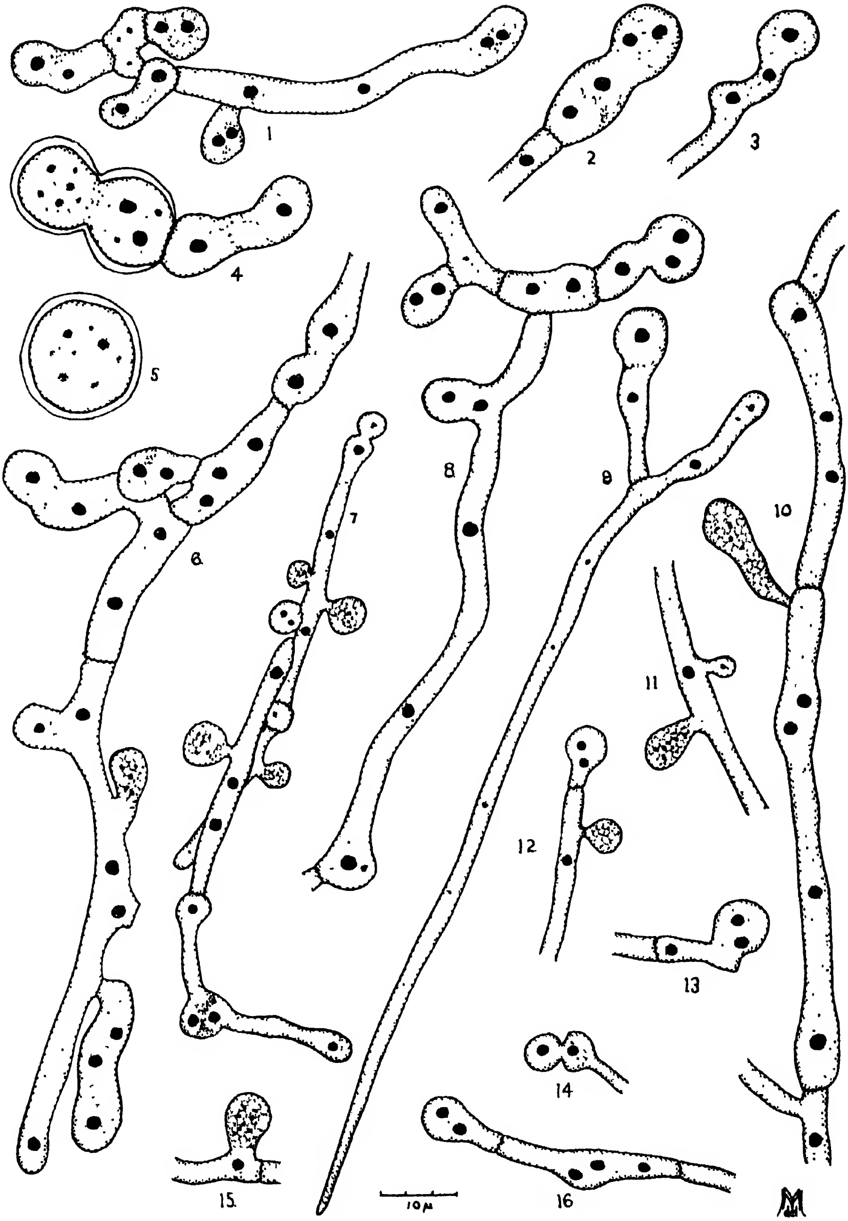
Fig. 11. Conidia on lactose agar.

Fig. 12. Terminal chlamydospore and lateral conidium or perhaps chlamydospore on beef extract plus blood serum agar.

Fig. 13. Lateral chlamydospore.

Figs. 14, 16. Cells of the above.

Fig. 15. Conidium on wort agar.



MOORE—ENDOMYCES CAPSULATUS

Explanation of Plate

PLATE 19

All drawings made with the aid of a camera lucida at × 1440.

Figs. 1–4. Germination of spores on 2 per cent bacto-peptone plus 5 per cent meat extract.

Fig. 5. Pyriform, sessile conidium on Richards' solution agar.

Fig. 6. Ascus.

Fig. 7. Hyphae showing round conidia and an intercalary chlamydospore.

Fig. 8. Mycelium with chlamydospores and conidia on Raulin's solution agar.

Fig. 9. Bit of young hypha with a large chlamydospore on Richards' solution agar.

Fig. 10. Terminal hypnospore and a lateral chlamydospore on Raulin's solution agar.

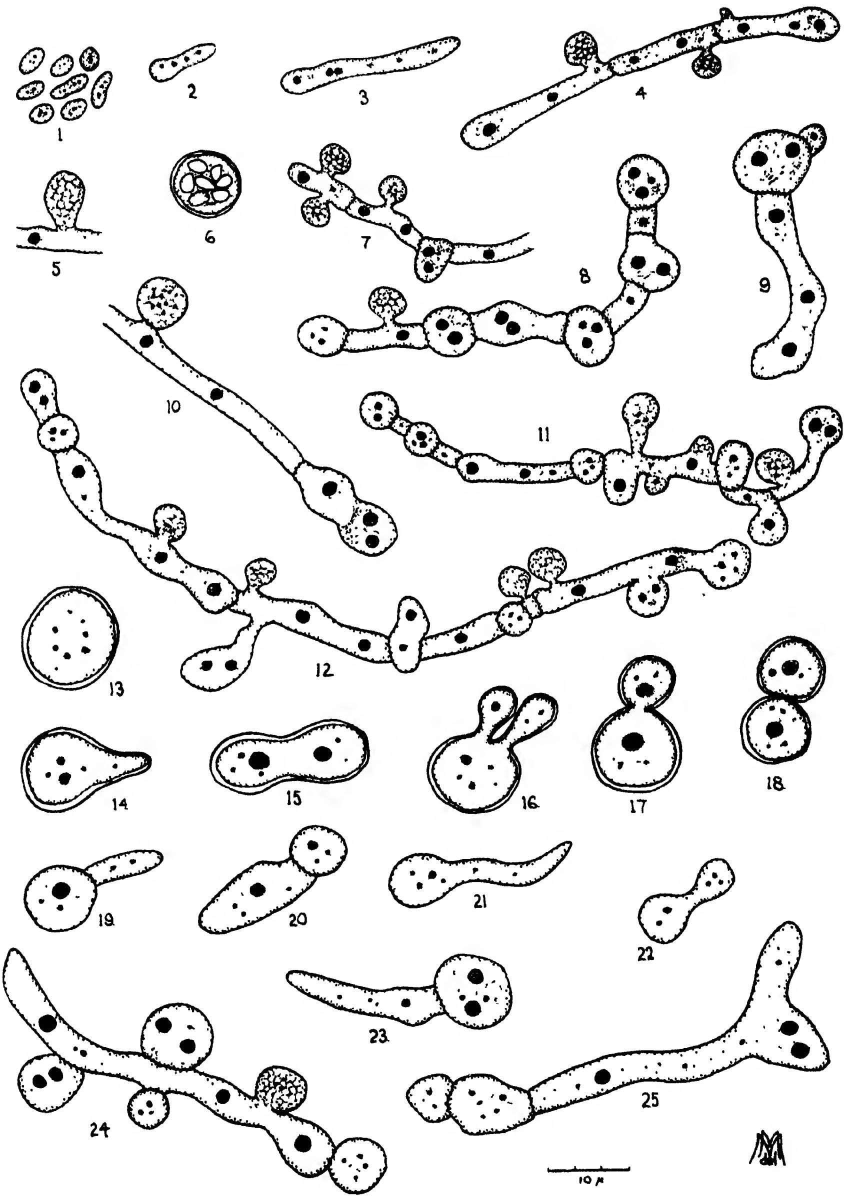
Fig. 11. Hypha with numerous pyriform and round conidia as well as chlamydospores.

Fig. 12. Hypha showing conidia, chlamydospores, and probably an ascogenous cell.

Figs. 13–25. Yeast-like cells and hyphae of the organism from the Austrian case on Sabouraud's agar.

Figs. 13–18. Showing budding.

Figs. 19–25. Formation of hyphae with conidia and chlamydospores.



MOORE—ENDOMYCES CAPSULATUS

Explanation of Plate

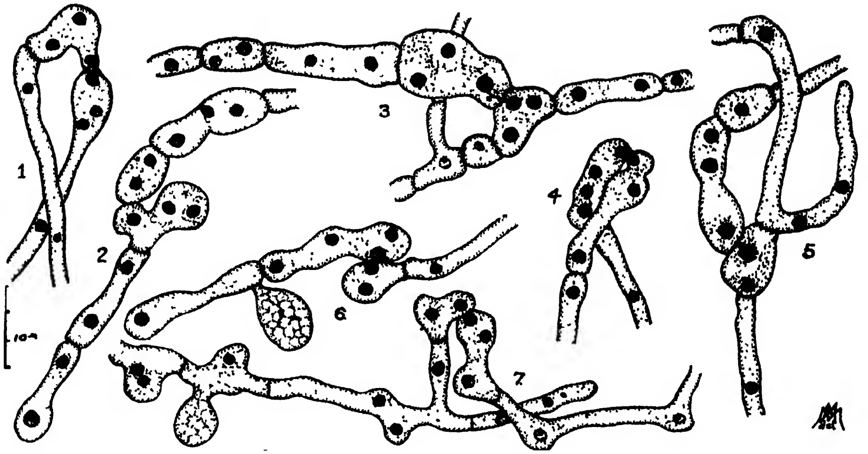
PLATE 20

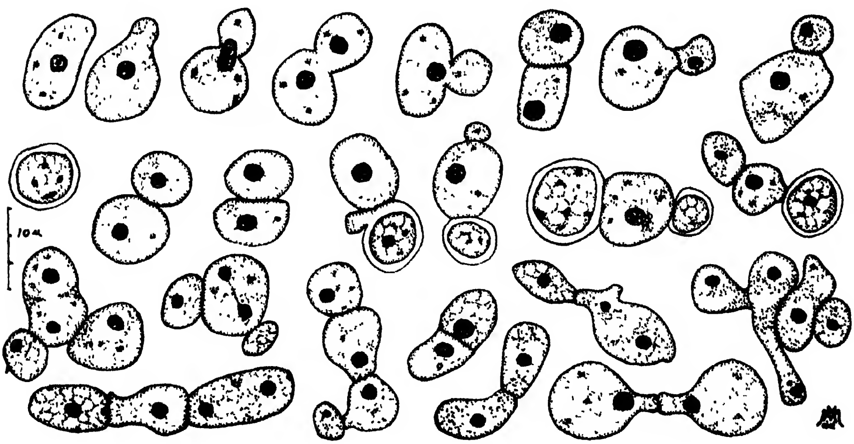
Forms of copulation drawn with the aid of a camera lucida at a magnification of × 1440.

Fig. 1. Terminal copulation.
Fig. 2. Probably a form of copulation.
Fig. 3. Termino-lateral copulation.
Fig. 4. Same as fig. 1.
Fig. 5. Same as fig. 3.
Fig. 6. Lateral form of terminal copulation.
Fig. 7. Terminal copulation.

B

Cells observed on a medium which contained a high pH. Reversion to a yeast-like form × 1440.





MOORE—ENDOMYCES CAPSULATUS

Explanation of Plate

PLATE 21

All drawings made at a magnification of × 1440 with the aid of a camera lucida.

Figs. 1–8. Yeast-like and budding cells on 2 per cent bacto-peptone (aqueous). Fresh isolation.

Figs. 9–11. Saccharomycetous cells developing mycelium in a hanging-drop culture of 2 per cent aqueous solution of bacto-peptone plus 5 per cent meat extract.

Figs. 12–13. Later stages of the above.

Fig. 14. Heterogamous copulation, premature stage on Sabouraud's agar.

Fig. 15. Heterogamous copulation seen at time of transfer of nuclear material, in hanging-drop of 2 per cent aqueous proteose peptone plus glycerine.

Fig. 16. Germinating spore on glycerine agar.

Fig. 17. Germinating spore developing hyphae on lactose agar.

Fig. 18. Developing ascus on Sabouraud's agar.

Fig. 19. Ascus showing 8 spores on nutrient agar.

Fig. 20. Racquet mycelium on lactose agar.

Fig. 21. Oidia-like cells formed in Sabouraud's broth.

Fig. 22. Ascus on potato-dextrose agar.

Fig. 23. Terminal hypnospore (chlamydospore) on glycerine agar.

Fig. 24. Large round chlamydospore with a thick wall on corn-meal agar.

Fig. 25. Section of a mycelium showing a thick-walled chlamydospore in a hanging-drop of 2 per cent bacto-peptone (aqueous).

Fig. 26. Mycelium with conidia on glycerine agar.

Fig. 27. Mycelium on eosine-methylene-blue agar.

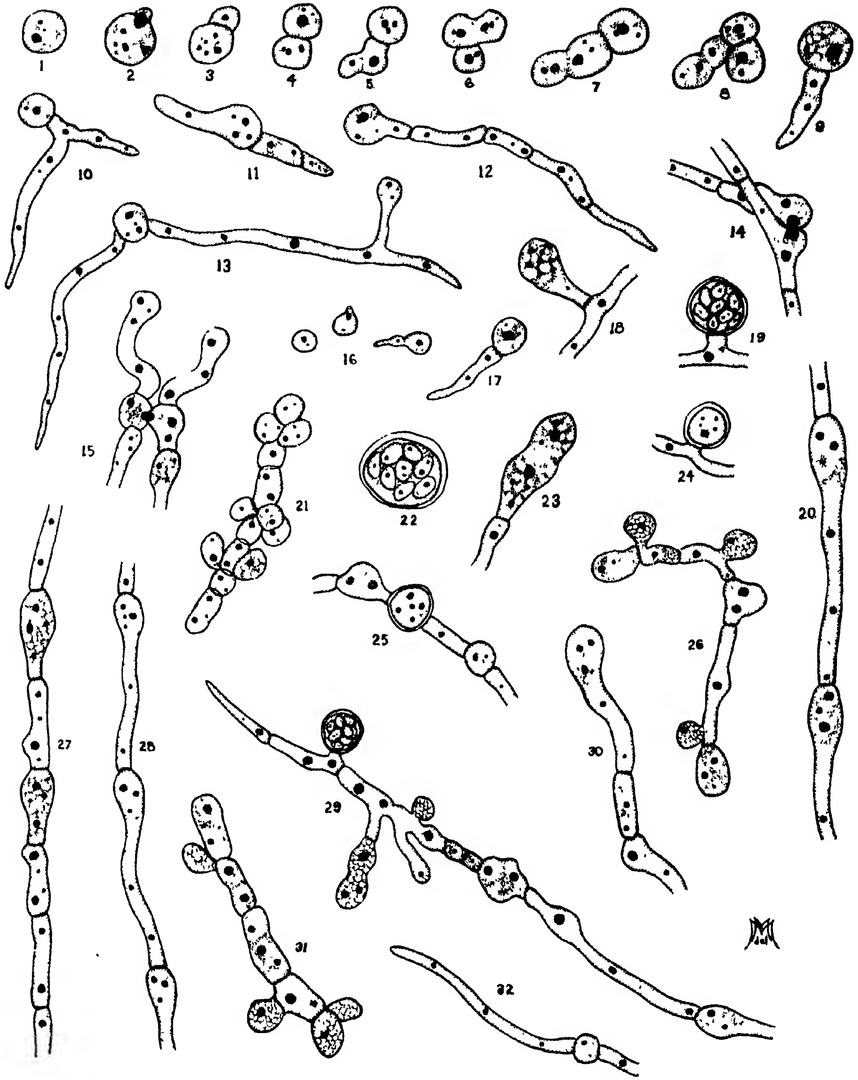
Fig. 28. Racquet mycelium on Sabouraud's agar.

Fig. 29. Mycelium showing racquet formation, conidia, hypnospores, and an 8-spored ascus, on glycerine agar.

Fig. 30. Terminal hypnospore on 2 per cent proteose peptone plus glycerine.

Fig. 31. Monilia-like growth in nutrient broth.

Fig. 32. Young hypha, 2 per cent bacto-peptone hanging-drop culture.



MOORE—ENDOMYCES CAPSULATUS

VAR. ISABELLINUS

Explanation of Plate

PLATE 22

All drawings made with the aid of a camera lucida and high oil-immersion magnification. × 2300.

All cultures grown on glycerine agar.

Figs. 1–3. Germinating spores. Fixed with Hermann's and stained with iron haematoxylin.

Fig. 4. Young hypha prior to septum formation showing many nuclei, some dividing.

Fig. 5. Hypha with septa formed.

Figs. 6–7. Antheridia with dividing nuclei. Fixed with Benda's and stained with iron haematoxylin.

Fig. 8. Nucleus after division. Fixed with Hermann's and stained with iron haematoxylin.

Fig. 9. Ascogonial cell.

Fig. 10. Copulation of antheridium and ascogonium of same hypha by means of a copulating tube.

Fig. 11. Copulation form with the antheridium larger than the ascogonium.

Fig. 12. Projection of copulating tube.

Fig. 13. Ascogenous cells with beginning fusion. Fixed with Benda's and stained with iron haematoxylin.

Fig. 14. Copulation of lateral cells. Fixed with Hermann's and stained with iron haematoxylin.

Fig. 15. Beginning dissolution of intervening walls in tube.

Fig. 16. Nuclear fusion.

Fig. 17. Transfer of nucleus to ascogonial cell and dissolution of tube.

Fig. 18. Fertilized ascogonium with large fusion nucleus, fixed in Hermann's and stained with iodine green.

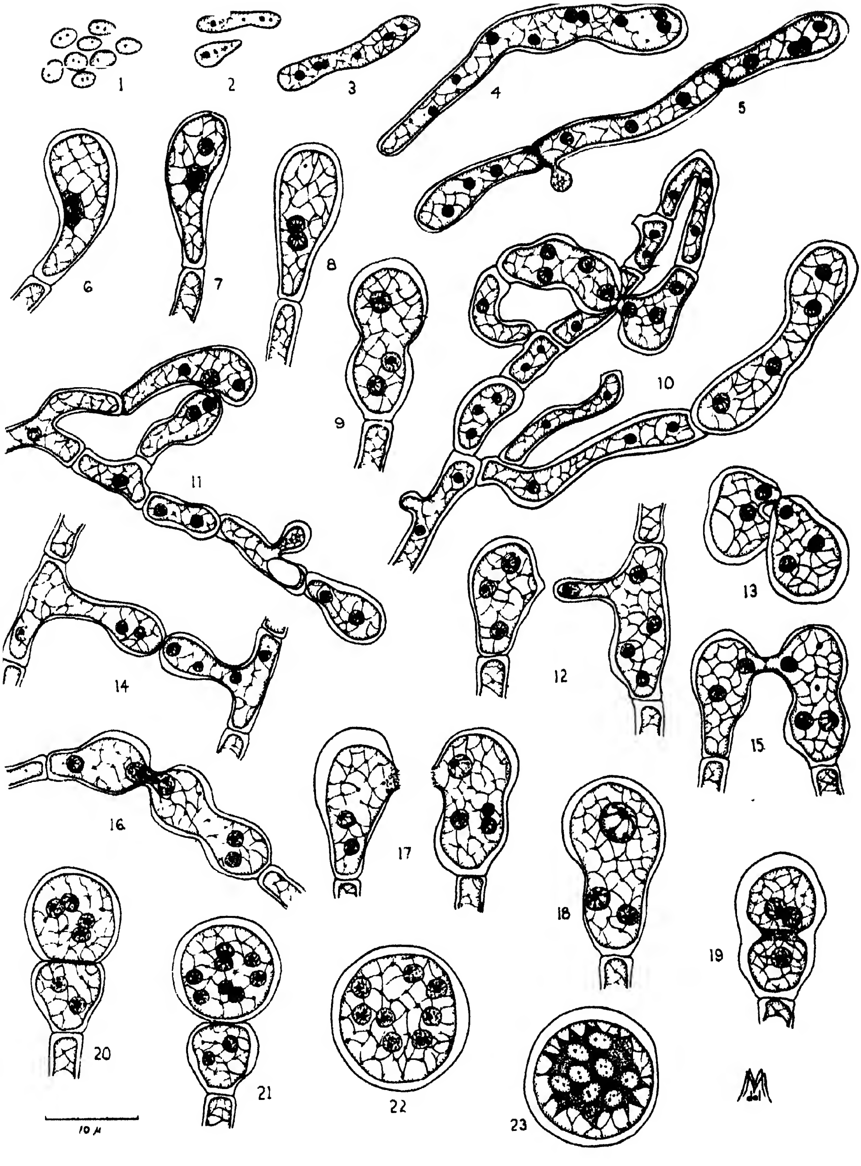
Fig. 19. Division of nucleus with beginning of formation of ascus, showing the abjunction of the special portion of the cell after syngamy. Fixed with Hermann's and stained with methylene blue.

Fig. 20. Synchronous division of nuclei. Fixed with Hermann's and stained with iron haematoxylin.

Fig. 21. Second synchronous division of nuclei with a rounding up of the future ascus.

Fig. 22. Maturation of ascus and ascospores.

Fig. 23. Matured spores in epiplasmic material.



MOORE—ENDOMYCES CAPSULATUS

Explanation of Plate

PLATE 23

All drawings made with the aid of a camera lucida and high oil-immersion magnification. × 2300.

Figs. 1–18. Grown on glycerine agar.

Figs. 19–38. Living material.

Figs. 1–9. Represent development of an ascus parthenogenetically. Fixed with Hermann's and stained with iron haematoxylin.

Fig. 10. Conidium.

Fig. 11. Cross-section of a cell showing the reticulated network.

Fig. 12. Two divided nuclei in a terminal cell.

Fig. 13. A parthenogenetically formed ascus (terminal) with spores in the center and surrounded with epiplasm.

Fig. 14. Terminal cell showing vacuoles formed by reticulum, fixed with Hermann's and stained with iodine green.

Fig. 15. Vacuolar formation in cell fixed with Hermann's and stained with methylene blue.

Fig. 16. Metachromatic granules stained with methylene blue.

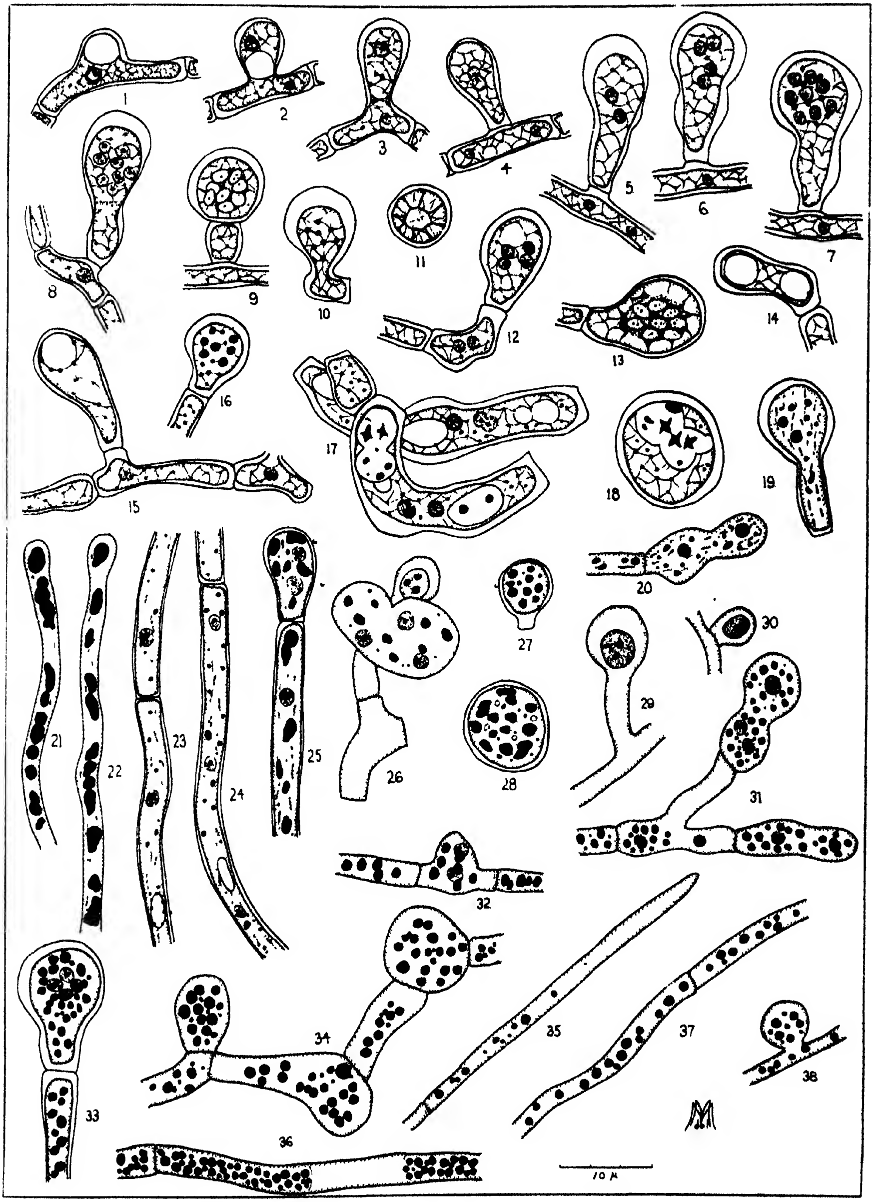
Figs. 17–18. Volutin in vacuoles.

Figs. 19–25, 27–28. Living cells stained and fixed with iodine potassium iodide, showing glycogen, lipoidal material and probable chondriosomes. The glycogen stains darkly (figs. 21–22, 25), the lipoidal substances are small, granular, and hyaline, and the chondriosomes are rod-like. Figs. 27–28 show young asci.

Figs. 26, 29–30. Living cells stained with neutral red, showing glycogen content.

Figs. 31–36. Living hyphae fixed with osmic acid, showing lipoidal or fat substances. Fig. 35, a young hypha, and fig. 36, an older hypha.

Figs. 37–38. Living material fixed with platinic chloride.



MOORE—ENDOMYCES CAPSULATUS

Annals
of the
Missouri Botanical Garden

Vol. 20 NOVEMBER, 1933 No. 4

SOURCES OF CARBOHYDRATE FOR GERMINATION AND GROWTH OF ORCHID SEEDLINGS

F. LYLE WYND

Formerly Assistant in the Henry Shaw School of Botany of Washington University

Ever since 1840, when Linck observed the endophytic fungus in orchid roots, the symbiotic relationship between these interesting plants has been studied by mycologists, plant physiologists, and horticultürists. We may roughly divide the research that has been done since 1840 into two main periods.

The first period consisted in efforts to verify the universality of the endophytic infection and to link this mycorrhizal condition with various phenomena of germination. Wahrlich ('86) was the first to establish the generality of the occurrence of the endophyte. He examined the roots of five hundred species of orchids and found all to be contaminated with a fungus which he held to be species of *Nectria*. Since the time of Wahrlich, the taxonomy of the fungal symbiont has passed through a complex and varied evolution, but a discussion of this phase of orchid research is beyond the scope of the present paper. The existence of the endophyte was further verified by Prillieux ('56, '60), Prillieux and Rivière ('56), and by Fabre ('56).

Bernard ('00) early suspected the relationship between the germination of orchid seeds and the presence of the endophyte. He obtained good germination on sawdust which was kept in the same greenhouse as the parent plants, and pointed out that this was probably due to an infection of the sawdust by the fungus from the parent plants. The publication of these results was followed by a number of other papers ('02, '03, '04, '06),

which further substantiated his opinions concerning the obligate relation between germination and the presence of a suitable fungus.

Burgeff ('09), in a monographic study of the various orchid endophytes, concluded, as had Bernard, that orchids were obligate symbiotic plants. He failed to recognize at that time the significance of his own experiment in which *Laelio-Cattleya* seeds germinated on a 0.33 per cent sucrose solution in the dark. The plants lived but ten months and further development either in the light or dark was impossible without the fungus. Had these cultures been exposed to light from the beginning, it is probable that he would have discovered the necessity of sugar rather than of the infected condition for normal development.

The second period of research began in a controversy over the possibility of germinating orchid seeds entirely asymbiotically. A complete review of this phase of the problem is without scientific interest. The writer cannot refrain, however, from quoting a sentence from Costantin ('26), which represents the resistance to the natural development of opinions from those of Wahrlich, Bernard, and Burgeff on the presence of the endophyte, to the latter views of Knudson on carbohydrate metabolism. Costantin said that Bultel was correct in saying that asymbiotic plants were normal externally, but—"Est-elle normale intérieurement? Non, si le champignon est absent: puisque sa présence est un des caractères de la vie normale de l'Orchidèe."

The research dealing with the carbohydrate nutrition of plants grown entirely asymbiotically centers in the work of Knudson. Previous to Knudson, Bernard had obtained, in a few cases, germination of *Cattleya* and *Laelia* seeds asymbiotically on concentrated solutions of salep. He even suggested that some such method might be developed commercially. Salep is a preparation obtained by reducing the dried tubers of certain orchids to powder and contains (Knudson, '22) 48 per cent mucilage, 27 per cent starch, 5 per cent protein, and probably some sugar and mineral matter. However, it remained for Knudson ('22, '24, '25, '26, '27) to point out that the true significance of the mycorrhizal condition was in furnishing a source of carbohydrate to the orchid embryo and in maintaining a favor-

able degree of acidity. A paper by Knudson ('16), previous to his work on orchids, called attention to the fact that sugars had a favorable influence on the growth of higher plants. The results obtained in this work, together with data taken from Bernard and Burgeff, suggested that soluble organic substance might cause germination. Germination was obtained on an agar culture prepared by autoclaving 400 gms. of dormant canna tubers with 600 cc. of water. Germination also occurred, with varying degrees of excellence, on peat agar, carrot-root extract, beet extract, and sugars. A complete mineral nutrient solution to which sugars were added gave good development. Fructose and glucose were the sugars used, fructose proving to be the better.

Germination and growth were obtained asymbiotically with the addition of sugars by Clement ('24 a, b, '26, '29, '32), Ballion and Ballion ('24, '28), and Bultel ('24–'25, '26). Bultel ('25) mentioned that fructose was preferable to glucose, but no experimental data were given.

While the above authors, building chiefly on the work of Knudson, sufficiently established the possibility of growing normal plants in the presence of sugar in the absence of the endophyte, La Garde ('29) was the first to study systematically the comparative value of the different sugars. Using 2 per cent solutions of maltose, glucose, fructose, and sucrose, he found their comparative value to be maltose > fructose > glucose > sucrose. A year later, Quednow ('30) published his observations on a more extended list of sugars. He found the order of excellence to be glucose > fructose > sucrose > maltose > mannite > galactose > lactose. Smith ('32) used sucrose, glucose, and maltose, singly and in all sorts of combinations, and observed no apparent difference in the growth of the seedlings.

Unusual facilities for research have enabled the writer to extend the list of sugars which has been used for orchid germination to include the rarer and more expensive forms. This opportunity, together with the discrepancies between the work of La Garde, Quednow, and Smith, led to the present work. The sugars were added to three different complete mineral nutrient solutions in amounts to give 7 gms. of carbon per liter. The compositions of these solutions were as follows:

Knudson's ('22) Solution		Shive's ('15) Solution		La Garde's ('29) Solution	
$MgSO_4.7H_2O$	.250 gm.	$MgSO_4.7H_2O$	4.930 gm.	$MgSO_4.7H_2O$	1.00 gm.
$Ca(NO_3)_2.4H_2O$	1.000 gm.	$Ca(NO_3)_2.4H_2O$	1.228 gm.	$Ca(NO_3)_2.4H_2O$	1.00 gm.
$(NH_4)_2SO_4$	.500 gm.	KH_2PO_4	1.960 gm.	KH_2PO_4	1.00 gm.
K_2HPO_4	.250 gm.			$CaCl_2$	1.00 gm.
				NH_4NO_3	.50 gm.
				$(NH_4)_2CO_3.H_2O$	.500 gm.

Iron was added in all cases as 10 cc. of a M/200 suspension of $FePO_4$ prepared according to Livingston ('19) in a liter of nutrient solution. Both Knudson and La Garde added iron in such quantities as to cause a heavy precipitate of iron phosphate. La Garde states that this precipitate was filtered off before the final sterilization and contained, besides iron and phosphate ions, calcium and potassium. It seems unwise to cause this bulky precipitate because it tends to adsorb other ions which are removed with it in filtration. The quantity of $FePO_4$ added by the author does not cause appreciable precipitation at the hydrogen-ion concentration used. This reduced amount is undoubtedly sufficient in quantity, since it is ten times that originally recommended by Livingston. La Garde designates the iron compound used by him as $Fe_3(PO_4)_2.8H_2O$. Knudson ('22), Quednow ('30), and Smith ('32) also added iron as ferrous phosphate. Since it is well known that the ferrous ion in the presence of oxygen reduces nitrate to nitrite, the ferric ion was used in the present work.

The solutions were made up in liter flasks, and adjusted to pH 4.00 with HCl. All precipitate dissolved at this acidity, but there was a slight opalescence due to ferric phosphate. The solutions were then titrated by means of the quinhydrone electrode to such pH (see tables) that the values after sterilization were 4.8–5.1. Aliquots of 100-cc. portions were placed in 200-cc. Erlenmeyer flasks and 1.75 grams of Merck's Reagent Powdered Agar added. Sterilization was by autoclaving at twenty pounds pressure for twenty minutes. The medium was allowed to solidify in a slanting position.

It is extraordinarily difficult to maintain sterile cultures in warm moist atmospheres over long periods of time, and after many preliminary failures, the following plan was adopted. The solutions were added to the culture flasks through a funnel, care

being taken not to moisten the necks of the flasks. The flasks were then closed with cotton plugs. A duplicate set of cotton stoppers was carefully and tightly rolled, sterilized in empty flasks in the autoclave, and then immediately transferred to the dry-air oven until thoroughly dry. The seeds were shaken vigorously for thirty minutes in a small vial of calcium hypochlorite prepared as recommended by Wilson ('15). This vial was then clamped in a sloping position so that contaminating substances might not fall in from the air. A culture flask and an empty flask containing the especially prepared cotton plug were held in a horizontal position in the left hand. The temporary cotton plug was withdrawn from the culture flask and dropped. A platinum-loop inoculating needle, held in the right hand, was quickly flamed and a loopful of seeds transferred directly from the hypochlorite solution to the drop of moisture that always exudes from the solidified agar. The neck of the flask was then flamed and the especially prepared stopper quickly drawn from the blank flask and inserted in the culture flask. This procedure is advisable as it involves a minimum of exposure of the cotton plug that is finally used in the culture flask, and insures its perfect dryness.

The drop of moisture containing the seeds on the edge of the agar was then distributed around the entire margin by rotating the flask carefully. This even distribution of seeds was maintained by placing the flask in a rack so constructed that the agar surface was perfectly level, thus preventing the liquid drop from draining to one side and carrying the seeds with it. After a convenient number of flasks had been inoculated, the necks of the flasks were again flamed and the cotton plug well charred on the surface. The plugs and the outer surface of the necks were then moistened with saturated $HgCl_2$ solution. Heavy waxed paper was then dipped in the $HgCl_2$ solution, tightly wrapped around the stoppers and the upper part of the flask, and held firmly in position by rubber bands. The writer has found that unless these precautions are taken, fungi will frequently grow along the surface of the flask and penetrate the stopper, contamination usually not appearing until three or four months after inoculation. Bernard, certainly a well-trained and experienced

mycologist, has commented on the extraordinary difficulty of maintaining orchid cultures sterile in the moist warm atmosphere desirable for germination. By taking the above precautions, the writer has maintained sterile cultures as long as three years in moisture-saturated atmosphere at 25–35° C.

In every case, the cultures were prepared in triplicate. The seeds for the entire series were from a single pod of *Cattleya Trianae* Linden & Rchb. f. The flower was pollinated November

TABLE I

DATA OF KNUDSON'S SOLUTION

Sugar	pH adjusted before sterilization	pH at time of planting	pH after supporting growth 8 months
d-glucose	4.12	5.1	4.2
d-fructose	4.12	4.9	3.8
d-galactose	4.12	5.0	No growth
d-mannose	4.13	5.0	4.2
l-xylose	4.15	5.0	No growth
l-arabinose	4.10	5.0	No growth
Maltose	4.15	5.1	4.4
l-rhamnose	4.15	5.0	No growth
Sucrose	4.15	5.1	4.4
Raffinose	4.12	4.8	4.4

TABLE II

DATA OF SHIVE'S SOLUTION

Sugar	pH adjusted before sterilization	pH at time of planting	pH after supporting growth 8 months
d-glucose	4.12	5.1	4.4
d-fructose	4.12	4.9	4.0
d-galactose	4.12	5.0	No growth
d-mannose	4.13	5.0	4.5
l-xylose	4.15	5.0	No growth
l-arabinose	4.10	5.0	No growth
Maltose	4.15	5.1	4.6
l-rhamnose	4.15	5.0	No growth
Sucrose	4.15	5.1	4.5
Raffinose	4.12	4.8	4.4

TABLE III

DATA OF LA GARDE'S SOLUTION

Sugar	pH adjusted before sterilization	pH at time of planting	pH after supporting growth 8 months
d-glucose	4.25	4.9	3.5
d-fructose	4.24	4.8	3.8
d-galactose	4.22	4.8	No growth
d-mannose	4.24	4.9	3.8
l-xylose	4.24	4.9	No growth
l-arabinose	4.24	4.9	No growth
Maltose	4.25	4.9	4.2
l-rhamnose	4.22	4.9	No growth
Sucrose	4.24	4.9	4.1
Raffinose	4.51	4.9	4.2

27, 1930, and the matured pod harvested March 11, 1932, after a developmental period of over sixteen months. The inoculation of the culture media was made June 15, 1932, and the observations were recorded February 25, 1933, after a growth period of about eight months.

In the younger stages of development the diameter of the protocorm is an accurate basis for comparative determinations of growth, but after the seedling has developed leaves the growth is largely vertical rather than mere enlargement of the nearly round protocorm. Accurate measurements of the height of the young plant are difficult to obtain, since it is too large to measure by a microscope micrometer and too small for any less accurate means. For these reasons, seedlings as old as eight months can best be rated with the eye by comparing different culture flasks and sorting them into a few groups. The results of such a comparison after the growth period of eight months are shown in table IV. The relative excellence of the cultures is designated by the number of X's.

The results show that d-mannose produced definitely the best growth. This is followed by the group glucose-maltose-fructose, and this in turn by the third group sucrose-raffinose, and then l-xylose. No growth was obtained on d-galactose, arabinose, or rhamnose. A comparison of these results with the molecular

TABLE IV

GROWTH DATA

Description of plants	Knudson's Mineral Solution		Shive's Mineral Solution		La Garde's Mineral Solution	
	Sugar	Growth	Sugar	Growth	Sugar	Growth
Group I Exceptionally good growth and chlorophyll development	d-mannose	xxxx*	d-mannose	xxxxx	d-mannose	xxxxx
Group II Moderately good growth and chlorophyll development	d-glucose maltose d-fructose	xxx xxx xxx	d-glucose maltose d-fructose sucrose	xxx xxx xxx xxx	maltose d-fructose	xxx xxx
Group III Poor growth and chlorophyll development	sucrose raffinose	xx xx	raffinose	xx	sucrose raffinose	xx xx
Group IV No growth	l-xylose d-galactose l-arabinose l-rhamnose	x 0 0 0	d-galactose l-arabinose l-rhamnose	0 0 0	l-xylose d-galactose l-arabinose l-rhamnose	x 0 0 0

*The number of x's denotes the relative excellence of the cultures.

configuration of the respective sugars indicates that in but one physical characteristic do they show any consistent physiological action—and that is that the pentoses do not allow the germination and growth of orchid seedlings. It is not impossible that their quality of being levo-rotatory is related to their physiological reaction. The two instances in which l-xylose allowed growth are of doubtful authenticity. Only two or three seeds germinated in each flask, and these never developed beyond a very rudimentary protocorm. Such rudimentary development was occasionally noted even on sugar-free agar cultures, but in those cases also development never proceeded beyond a rudimentary protocorm. It is interesting to note that rhamnose, although it

has six carbon atoms, is structurally a methylated pentose and reacts physiologically to orchid seedlings as a pentose. Galactose, although an aldo-hexose, as is also d-mannose, supported no growth. These results are in approximate agreement with those of Quednow, cited above.

From the following considerations the author believes that the conspicuous superiority of d-mannose is of especial significance. Mannose, in the form of mannan, is known to be widely distributed as a constituent of the cell wall of many plants. This is particularly true of seeds (Onslow, '23). For example, various complex mannans have been found in the seeds of palms, asparagus, clover, coffee bean, onion, and various Leguminosae, Coniferae, and Umbelliferae. Mucilages are particularly rich in mannans, as, for instance, those obtained from lily bulbs (Parkin, '01) and tubers of various genera of Orchidaceae. Pringsheim and his coworkers ('24, '28) succeeded in isolating and studying mannan from orchid tubers. In this instance, it was water soluble and was precipitated by alcohol as a white powder. Klein ('32) gives a procedure for isolating mannan from salep itself.

Salep, a product of orchid tubers, has been used as a substrate for the orchid fungi and for germinating orchid seeds in the presence of some symbiotic fungus from the earliest days of orchid research. It therefore appears fairly certain that the fungal element of the orchid mycorrhiza is able to hydrolyze mannan to soluble mannose. In this way the symbiotic fungi could make available any mannose which might be present in the woody and mossy substrate of epiphytic orchids in their natural habitat. The extraordinary slowness of the development of orchid seedlings would be supported by the presence of only very small quantities of mannan.

The Missouri Botanical Garden has produced seedlings by the symbiotic method that surpassed in quality anything that the author has seen obtained by asymbiotic methods. In many instances the agar substrate consisted of the usual mineral substances and finely shredded cocoanut fiber. An appropriate fungus was inoculated on this medium some time before the seeds were sown. Seedlings grown on fungus-inoculated cocoanut-

fiber substrate always surpassed those grown on La Garde's maltose media. Bultel ('25) also found that symbiotic cultures gave superior results with all genera tested by him except Phalaenopsis. The nature of his substrate was not indicated.

The writer has already reported ('33) on the superior value of the La Garde mineral solution over other solutions, and it seems scarcely probable that symbiotic cultures could owe their superiority to any inorganic constituent. It is much more probable that the carbohydrate relationship is the important feature. Knudson has shown the effectiveness of orchid fungi in hydrolyzing starch to available sugar. Might not the superiority of the symbiotic cultures be due to the mannose produced by hydrolysis from the cocoanut fiber?

In order to determine the actual presence of mannans in cocoanut fiber, an analysis was carried out according to the method of Haegglund and Klingstedt ('24, '27). Ten gms. of cocoanut fiber were allowed to stand in 150 cc. of 72 per cent H_2SO_4 for 2½ days. The mixture was then diluted with water and the acid neutralized with $CaCO_3$. The precipitate was filtered off, the residue washed on a suction filter, and the combined filtrate and washings were evaporated on the steam bath to 150 cc. Then H_2SO_4 was added to give a 2 per cent solution and the mixture boiled 2 hours. The acid was again neutralized with $CaCO_3$, then weakly acidified with $HC_2H_3O_2$, and evaporated to 100 cc. After cooling, 10 cc. of phenylhydrazine plus 20 cc. water were added and allowed to stand several days. A very definite precipitate of the insoluble phenylhydrazone was obtained, indicating the presence of mannose.

The above method is scarcely quantitative because of the difficulty of obtaining complete hydrolysis of mannans without causing their oxidation at the same time. The very heavy precipitate of $CaSO_4$ which is produced when the acid is neutralized with $CaCO_3$ is bulky and difficult to wash thoroughly.

The seedlings grown on La Garde's maltose solution equalled those of the same age originally obtained by La Garde. Hence the mannose cultures might be regarded as distinctly superior to those yet obtained by the use of a purely synthetic medium and approach in quality the best of the symbiotic cultures. It

is to be regretted, however, that this could not be verified positively by comparison, since seedlings of the same age grown symbiotically were not at hand.

The glucose cultures were also of high quality, particularly as to their green color. No trace of yellowness or of inferior chlorophyll development was observed in seedlings grown on this sugar.

It must be noted that superiority of symbiotic cultures may depend not only on a carbohydrate relation, but also on a favorable degree of acidity. Knudson has pointed out that satisfactory fungal symbionts maintain a favorable pH of the media for the germination of the seeds. The pH of asymbiotic media can, of course, be adjusted artificially, but the initial favorable acidity is difficult to maintain over long periods of time.

The author hopes that some worker equipped to carry both symbiotic and asymbiotic cultures simultaneously will test further the suggestion that symbiotic cultures owe their superiority to mannose and to the constantly favorable pH relationship.

SUMMARY

1. The growth of orchid seedlings over a period of eight months was observed on a series of sugars, each added to three different inorganic media in amounts to give seven grams of carbon per liter. The order of excellence of growth on the different sugars was: d-mannose $>$ d-glucose $>$ maltose $>$ d-fructose $>$ sucrose $>$ raffinose.

2. No growth was obtained on d-galactose, and the pentoses, l-arabinose, l-rhamnose, and l-xylose. This inability of the pentose sugars to support growth may be related to their levorotating property. Galactose occupies an anomalous position.

3. Mannose gave conspicuously the better growth. This may be related to the fact that symbiotic cultures containing cocoanut fiber, an effective source of mannan, produce seedlings superior to any that the author has seen produced asymbiotically.

4. The mineral nutrient medium of La Garde plus d-mannose is regarded as the best asymbiotic culture medium for orchids, as shown by the reaction of *Cattleya Trianae* Linden and Rchb. f. seedlings.

ACKNOWLEDGMENTS

The author wishes to thank Dr. E. S. Reynolds, Physiologist to the Missouri Botanical Garden, for helpful suggestions throughout the work, and Dr. G. T. Moore, Director of the Missouri Botanical Garden, for the supply of orchid seeds.

BIBLIOGRAPHY

Ballion, G., and Ballion, M. ('24). The non-symbiotic germination of orchid seed in Belgium. Orchid Rev. **32**: 305–309. 1924.

————, ————, ('28). Asymbiotic germination of orchid seed. *Ibid.* **36**: 103–112. 1928.

Bernard, N. ('00). Sur quelques germinations difficiles. Rev. Gén. Bot. **12**: 108–120. 1900.

————, ('02). Études sur la tubérisation. *Ibid.* **14**: 5–25, 58–71. 1902.

————, ('03). La germination des orchidées. Comp. Rend. Acad. Sci. Paris **137**: 483–485. 1903.

————, ('04). Recherches expérimentales sur les orchidées. Rev. Gén. Bot. **16**: 405–451, 458–476. 1904.

————, ('06). Symbiosis d'orchidèes et de divers champignons endophytes. Comp. Rend. Acad. Sci. Paris **142**: 52–54. 1906.

Bultel, G. ('24–'25). Germinations aseptiques d'orchidées. Cultures symbiotique et asymbiotique. Rev. Hort. Paris **96**: 268–271. 1924; **97**: 318–321, 359–363. 1925.

————, ('26). Les orchidées germées sans champignons sont des plantes normales. *Ibid.*, **98**: 155. 1926.

Burgeff, H. ('09). Die Wurzelpilze der Orchideen, ihre Kultur und ihr Leben in der Pflanze. Jena, 1909.

Clement, E. ('24a). Germination of Odontoglossum and other seed without fungal aid. Orchid Rev. **32**: 233–238. 1924.

————, ('24b). The non-symbiotic germination of orchid seeds. *Ibid.* 359–365. 1924.

————, ('26). The non-symbiotic and symbiotic germination of orchid seeds. *Ibid.* **34**: 165–169. 1926.

————, ('29). Non-symbiotic and symbiotic germination of orchid seed. *Ibid.* **37**: 68–75. 1929.

-, ('32). Raising orchid seedlings. *Ibid.* **40**: 195–206. 1932.

Costantin, J. ('26). La vie asymbiotique des orchidées. Ann. Sci. Nat. Bot. **8**: I–XIV. 1926.

Fabre, J. H. ('55). Recherches sur les tubercules de l'*Himantoglossum hircinum*. *Ibid.* IV. **3**: 253–291. 1855.

————, ('56). De la germination des ophrydées et de la nature de leurs tubercules. *Ibid.* IV. **5**: 163–186. 1856.

Haegglund, E., und Klingstedt, F. W. ('24). Cellulose-Chemie **5**: 58. 1924.

————, ————, ('27). Zur Charakterisierung von Cellulosepräparaten mittels der Drehwertsmethode. Ann. der Chem. **459**: 26–38. 1927.

Klein, G. ('32). Organische Stoffe. Membranstoffe. Handb. d. Pflanzenanalyse $\mathbf{2^2}$: 48. 1932.

Knudson, L. ('16). Influence of certain carbohydrates on green plants. Cornell Agr. Exp. Sta. Mem. 9: 1–75. 1916.

———, ('22). Non symbiotic germination of orchid seeds. Bot. Gaz. 73: 1–25. 1922.

———, ('24). Further observations on non-symbiotic germination of orchid seeds. *Ibid.* 77: 212–220. 1924.

———, ('25). Physiological study of the symbiotic germination of orchid seeds. *Ibid.* 79: 345–380. 1925.

———, ('26). Physiological investigations on orchid seed germination. Internat. Cong. Pl. Sci. Ithaca, Proc. 1183–1189. 1926.

———, ('27). Symbiosis and asymbiosis relative to orchids. New Phytol. 26: 328–336. 1927.

La Garde, R. V. ('29). Non-symbiotic germination of orchids. Ann. Mo. Bot. Gard. 16: 499–514. 1929.

Livingston, B. E. ('19). A plan for cooperative research on the salt requirements of representative agricultural plants. 1–54. 2nd ed. Baltimore, 1919.

Onslow, Muriel Wheldale ('23). Practical plant biochemistry. Cambridge, 1923.

Parkin, J. ('01). On a reserve carbohydrate which produces mannose, from the bulb of Lilium. Cambridge Phil. Soc., Proc. 11: 139–142. 1901.

Prillieux, E. ('56). De la structure anatomique et du mode de végétation du *Neottia nidus avis*. Ann. Sci. Nat. Bot. IV. 5: 267–282. 1856.

———, ('60). Observations sur la germination du *Miltonia spectabilis* et de diverses autres orchidées. *Ibid.* 13: 288–296. 1860.

-, et Rivière, A. ('56). Observations sur la germination et le développement d'une orchidée. *Ibid.* 5: 119–136. 1856.

Pringsheim, H., und Genin, A. ('24). Über die fermentative Spaltung des Salepmannans. VI. Mitteilung über Hemicellulosen. Zeitschr. f. physiol. Chem. 140: 299–304. 1924.

———, und Liss, G. ('27). Über das Salep-Mannan. Liebig's Ann. der Chem. 460: 32–42. 1927.

Quednow, K. G. ('32). Beiträge zur Frage der Aufnahme gelöster Kohlenstoffverbindungen und andere Pflanzen. Bot. Archiv. 30: 51–108. 1930.

Ramsbottom, J. ('22). The germination of orchid seed. Orchid Rev. 30: 197–202. 1922.

Shive, J. W. ('15). A three salt nutrient solution for plants. Am. Jour. Bot. 2: 157–160. 1915.

Smith, F. E. V. ('32). Raising orchid seedlings asymbiotically under tropical conditions. Gard. Chron. 91: 9–11. 1932.

Wahrlich, W. ('86). Beitrag zur Kenntniss der Orchideenwurzelpilze. Bot. Zeit. 44: 481–488, 497–505. 1886.

Wilson, J. K. ('15). Calcium hypochlorite as a seed sterilizer. Am. Jour. Bot. 2: 420–427. 1915.

Wynd, F. L. ('33). Nutrient solutions for orchids. Ann. Mo. Bot. Gard. 20: 363–372. 1933.

SUPER OPTIMAL AND THERMAL DEATH TEMPERATURES OF THE COTTON PLANT AS AFFECTED BY VARIATIONS IN RELATIVE HUMIDITY[1]

DOROTHY MEGOWEN BERKLEY

Formerly Jessie R. Barr Fellow in the Henry Shaw School of Botany of Washington University

AND EARL E. BERKLEY

Research Fellow in the Henry Shaw School of Botany of Washington University[2]

HISTORICAL REVIEW

In 1863 Sachs reported the results of an attempt to determine the effects of high temperatures on the sensitivity of *Mimosa pudica.* Transitory insensitivity, he found, was caused by an exposure of one hour to a temperature of 40° C., and at 45° C. for a half hour and 49° C. for a very brief time the same effect was produced. When permanent insensitivity was attained, at higher temperatures, death invariably followed. Sachs also reported ('64) on the effects of high temperatures on tobacco, pumpkin, corn, nasturtium, and rape, exposed for various periods of time. All the plants were able to withstand temperatures of 49–51° C., but none survived 51° C. for more than 10 minutes without injury. The power of resistance to high temperatures was found to vary at different ages. Developing leaves, stems, and roots were more easily killed than older ones.

Ewart ('03) noted a decrease in the rate of protoplasmic streaming in *Elodea, Tradescantia, Chara, Spirogyra,* root hairs, pollen tubes, etc., depending upon the height of the temperature above the optimum and upon the length of exposure.

Pfeffer ('03) made the generalization that all turgid plants ultimately die when the temperature reaches from 1° to 2° C. above the maximum where the plant will grow indefinitely, although growth may continue for a time, and that at temperatures of 10° C. above this maximum all flowering plants seem to be rapidly killed. He noted that plants, which at first

[1] Portions of this work, together with certain microscopical studies of the treated plants, were submitted by Mrs. Dorothy Megowen Berkley as a thesis in partial fulfillment of the requirements for the degree of master of science in the Henry Shaw School of Botany of Washington University.

[2] A fellowship established by the American Creosoting Co.

appeared fresh and unharmed after a short exposure to fatally high temperatures, frequently died later as an after-effect, even under the best external conditions.

Fung ('11) emphasized the necessity of considering the relative humidity in determining the effects of high temperature on plants. He found the maximum temperature for growth of cotton to be 113° F. in a relative humidity of 90 per cent and the optimum 85–90° F. in a relative humidity of 70.6–72.2 per cent. Cotton plants treated for four hours in a saturated atmosphere at a variety of high temperatures also gave interesting results. At 42–45° C. the stems and leaves were badly wilted but recovered; at 44–48° C. the stems and leaves were browned but new leaves appeared after one week (probably secondary growth from uninjured nodes); at 49–55° C. the plants were killed. The degree of injury was determined after the plants had been transferred to "proper conditions," which were not described. The value of Fung's results is limited by the fact that he worked with an insignificant number of plants and used only very young seedlings. Bose ('13), who gave 60° C. as the average fatal temperature for plants in general, found the death point to be lower in young plants, which confirmed the earlier statement of Sachs.

Collander ('24) determined the temperatures at which death occurred in individual cells of various plants. *Tradescantia discolor* was killed at 65° C. within an average of 1.8 minutes, *Brassica oleracea* at 60° C. within an average of 0.8 minute, *Beta vulgaris* at 60° C. in 0.7 minute, *Draparnaldia glomerata* at 55° C. in 0.32 minute, and *Pisum sativum* at 55° C. in 0.095 minute. He found that these plants could live at slightly lower temperatures for some time, thus demonstrating that the thermal death point is suddenly reached. Lepeschkin ('25) discussed the effects of optimum, maximum, and thermal death temperatures on bacteria, fungi, and higher plants. He stated that most plants died at 60–70° C. in one minute, although some died at 40–45° C. in that time.

Gilbert ('26) found that cotton grew better at 80° F. in a relative humidity of 50 per cent than it did in a relative humidity of 85 per cent. Wallace ('31) tested the effect of 1–24-hour

exposures to temperatures ranging from 15 to 60° C. on the sensitivity of *Mimosa pudica.* Above 45° C. injury or death resulted, depending upon the length of the exposure. He reported that the relative humidity had little or no effect upon the sensitivity of the plant.

Baker ('29), in studying the effects of excessively high temperatures on conifer seedlings 1–3 months old, also emphasized the suddenness at which the thermal death point was reached. The living tissues were quickly killed at 54° C. but were uninjured after a prolonged exposure to a temperature only a few degrees lower. Just below the thermal death point he noted a region of no growth where photosynthesis was apparently unable to keep up with catabolic changes, the chlorophyll decomposing faster than it was made and the leaves becoming yellow or withered. On prolonged exposure the plants died. He also found the age of the plant to be a factor in resistance, due to the development of protective tissues as the plant grew older. The indications were that there was no increased protoplasmic resistance with age.

APPARATUS

Four glass cases of identical design and size (60 in. long by 32 in. wide by 40 in. high) were used for the experimental work. Three of these cases were variously used for growing plants, for germinating seeds, and for plants under observation following treatment. Additional plants were grown on benches in the experimental room.

The fourth case was converted into the electrically controlled temperature chamber (fig. 1). The experimental plants were placed in a flat of sand which rested on a lattice rack supported 12 inches above the bottom of the case. The heating units consisted of three heaters, two of which were controlled by ordinary switches, and were placed on the floor of the case, one in either half about midway between the center line and the end. They were composed of resistance wires wrapped on racks which extended practically the width of the case. With these two heaters there were three possible combinations: when the two were in parallel maximum heat was obtained, when one was used alone approximately one-half of the maximum could be had, and

when the two were in series one-fourth of the maximum. A further reduction in temperature was obtained by turning off these heaters altogether, leaving only the third heater which was composed of resistance wire wrapped on the guard-wires of an electric fan. This heater was controlled by a Thyratron[1] and relay combination which in turn was controlled by a thermostat with a mercury make-and-break contact.

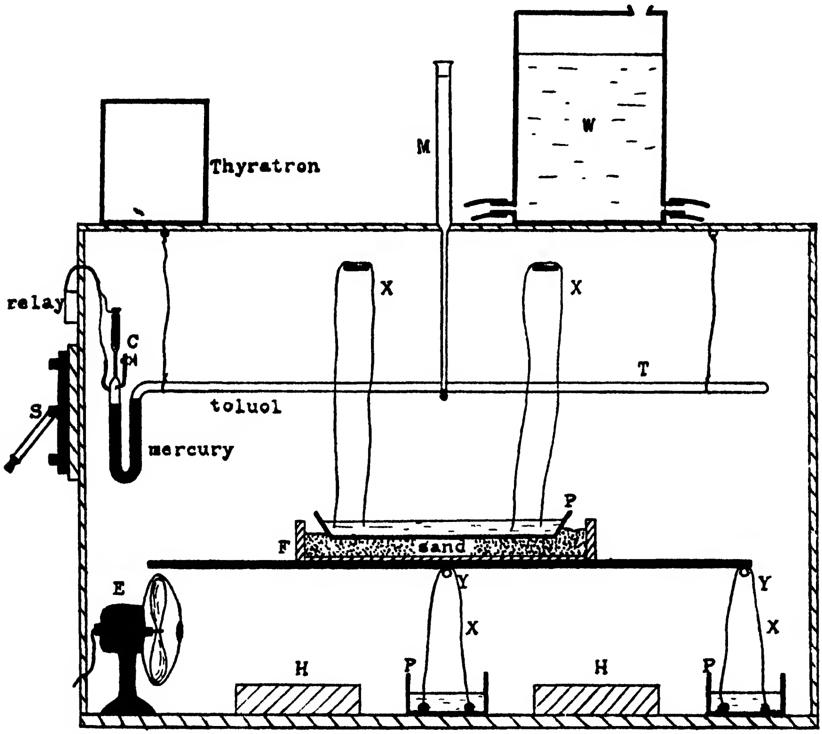


Fig. 1. Diagrammatic cross-section through the center of the controlled temperature chamber in which the plants were treated. C, capillary; E, electric fan heater; F, greenhouse flat; H, floor heaters; M, thermometer; P, water pans; S, switches; T, thermostat; W, water tank; X, humidifying cloths; Y, spray tubes.

The fan, which was located on the floor at one end of the chamber, was hooked directly to the current so that it ran continuously, blowing the warm air over the heaters and through

[1] Schmitt, F. O., and Schmitt, O. H. A. A vacuum tube method of temperature control. Science N. S. 73: 289–290. 1931.

humidifying cloths made of cheese-cloth. In this way the heat and moisture were uniformly distributed throughout the compartment. Good ventilation was assured by boring small holes in the frame of the compartment on either side of and in back of the fan.

The thermostat consisted of a glass tube extending the full length of the chamber, one end of which was shaped into a U terminating in a capillary. The main body of the tube had a capacity of about 200 cc. and was filled with toluol; the U tube, with a capacity of about 20 cc., contained mercury. The contact was made in the capillary in the usual manner. Due to the large capacity of this tube and the fact that it extended across the case at a level with the tops of the plants, it was possible to control the temperature within 0.5 of a degree.

The temperature of the chamber was determined by means of an incubator thermometer inserted through the top of the case, with its bulb reaching down to the level of the plants in the center.

For experiments run at high humidity, a practically saturated atmosphere was obtained by hanging from four pans at the top of the chamber strips of cloth which were kept supplied with water by tubes running from a tank above. These cloths drained into three pans below, one of which was placed in the flat of moistened sand and the others located on the floor. Additional cloths, through which the warm air from the fan was blown, extended the entire width of the temperature chamber below the rack and were moistened by constant sprays of water. An overflow in the bottom pans, which received most of the run-off water, was avoided by the use of constant-level siphons which carried off the surplus through drains in the floor.

Still other cloths were hung above either end of the pan in which the plants were placed, so that the pots of plants were not only standing in water but were more or less surrounded by moist cloths. Under these conditions the relative humidity was so high that the entire inner surface of the temperature chamber was covered with a film of water which dripped from the top and ran down the glass sides in streams.

For the low-moisture experiments, all humidifying devices were removed from the chamber.

Since there is no method devised at the present time for measuring the relative humidity at temperatures above 50° C., it was decided to measure the evaporating power of the atmosphere. This was done by the use of atmometers which consisted of two porous cups of the cylinder type connected to burettes on the outside of the chamber, all connections being made under water to eliminate air bubbles. These atmometers were carefully filled with boiled water, and placed on either side of the flat on which the plants were to be set. Notched corks were placed in the top of each burette to prevent evaporation at that point. After the chamber had been adjusted to a desired temperature, readings were made on the burettes at regular intervals. The results of these readings are shown in fig. 2.

At the high relative humidity, after the humidifying apparatus had been thoroughly adjusted, there was very little evaporation from the atmometers. Even at the higher temperatures, with no plants in the temperature chamber, there was less than 0.001 cc. evaporation per minute. These results give some indication of the conditions existing within the chamber, although it is not intended to imply that the plants lost water at exactly the same rate as the atmometers.

At temperatures below 50° C. an approximately saturated relative humidity for the higher moisture experiments and an average of 69 per cent for the lower moisture experiments were calculated from the readings of wet and dry bulb thermometers. When readings were made with the plants in the chamber, the relative humidity varied with the time of day, being as low as 55 per cent at night when transpiration was cut to a minimum and as high as 78 per cent at mid-day. Accordingly, most of the plants at the lower humidity were treated during the day. Since transpiration raised the relative humidity of the chamber, care was taken, when watering the plants in preparation for treatment, to keep the foliage dry and to allow the water to soak into the soil before placing them in the temperature chamber.

PROCEDURE

These experiments were made in order to determine the effects of humidity of super optimal and thermal death temperatures on

the cotton plant. They were suggested by the previous work of Berkley ('31) and the unpublished studies of Fung ('11). Cotton plants (variety Upland Big Ball) were grown in pots containing a mixture of sand and loam in a room of the greenhouse having a usual temperature of 25–30° C. Since individual variations made it necessary to use large numbers of plants of various ages, seeds were planted at frequent intervals from September, 1931, until the following September.

Two distinct series were run, one at a low, and the other at a high, relative humidity. The low-humidity experiments were made at temperatures between 42 and 84° C. inclusive, and those at the high humidity, between 40 and 65° C.

Plants of various ages (their ages being computed from the day the seeds were planted) were exposed to a particular temperature and humidity combination. After the chamber had been adjusted to the desired temperature, the plants were quickly passed through one of the glass doors, the slight drop in temperature occasioned by their entrance being quickly adjusted. They were removed after treatment to a compartment at room temperature which had a relative humidity similar to that of the treating chamber. The subsequent behavior of all plants treated was watched and the results noted. A minimum of 24 hours was allowed to elapse before the plants were pronounced dead. When the leaves and the growing tip of a plant were killed, it was called "dead" but was kept watered for some days to allow secondary growth to take place at the nodes in case the entire plant had not been killed. Such plants as did put forth secondary growth are listed in the tables. It will be noted that this was characteristic of the higher humidity experiments only.

SERIES I

Low humidity.—The plants treated at the lower relative humidity wilted to some extent before they were removed from the temperature chamber. When not too severely injured by excessive treatment, they revived and became turgid again immediately after removal. When treated for a longer time than was necessary to kill them, the wilted leaves and cotyledons temporarily regained their turgidity and to all appearances were

unharmed, but the petioles of the younger leaves, the stems just below the growing tips, and the hypocotyls of the seedlings were withered beyond recovery. After some hours, the time depending upon the intensity of the treatment, the injured portions of all plants, including those that temporarily recovered, dried up, only the cotyledons and leaves remaining green and turgid. These living organs, connected to the main stem of the plant only by dead tissue, remained in the green condition from 3 to 14 days before showing signs of death.

A microscopic study revealed no living tissue in the withered portions of the petioles and hypocotyls, but in the leaves and growing tips, which had recovered, the tissue was found to contain a number of mitotic figures. In the meristematic regions of the plants treated at times and temperatures just sufficient to kill them, the cell contents were disorganized.

Very few of the plants whose growing tips were killed put forth secondary growth at the nodes.

Tables I and II and fig. 3a give the detailed results of the lower humidity experiments. The thermal death point for the older plants treated at the lower relative humidity is in the neighborhood of 63° C., as shown by a sudden break in the line when the temperature is plotted against the time (fig. 3a). The time required to kill all of the plants at this temperature was about 7 minutes. The evaporation rate of the atmometer at 63° C. was 0.26 cc. per minute (fig. 2 and table II). If the plants were evaporating at a similar rate the cooling effect of the evaporation would be appreciable and would account for the greater length of time necessary to kill the plants at this temperature than at slightly higher temperatures.

The seedlings 10 days old or less had a slightly lower and more variable critical temperature (table I). The cotyledons and plumules showed about the same resistance as the older plants but the hypocotyls were permanently injured when treated for 8 minutes at 60° C. This injury to the hypocotyls ultimately caused the death of the entire plant.

In the older plants the petioles of the succulent young leaves were similarly affected but the plants were not killed unless the treatment was prolonged until the younger portion of the stem

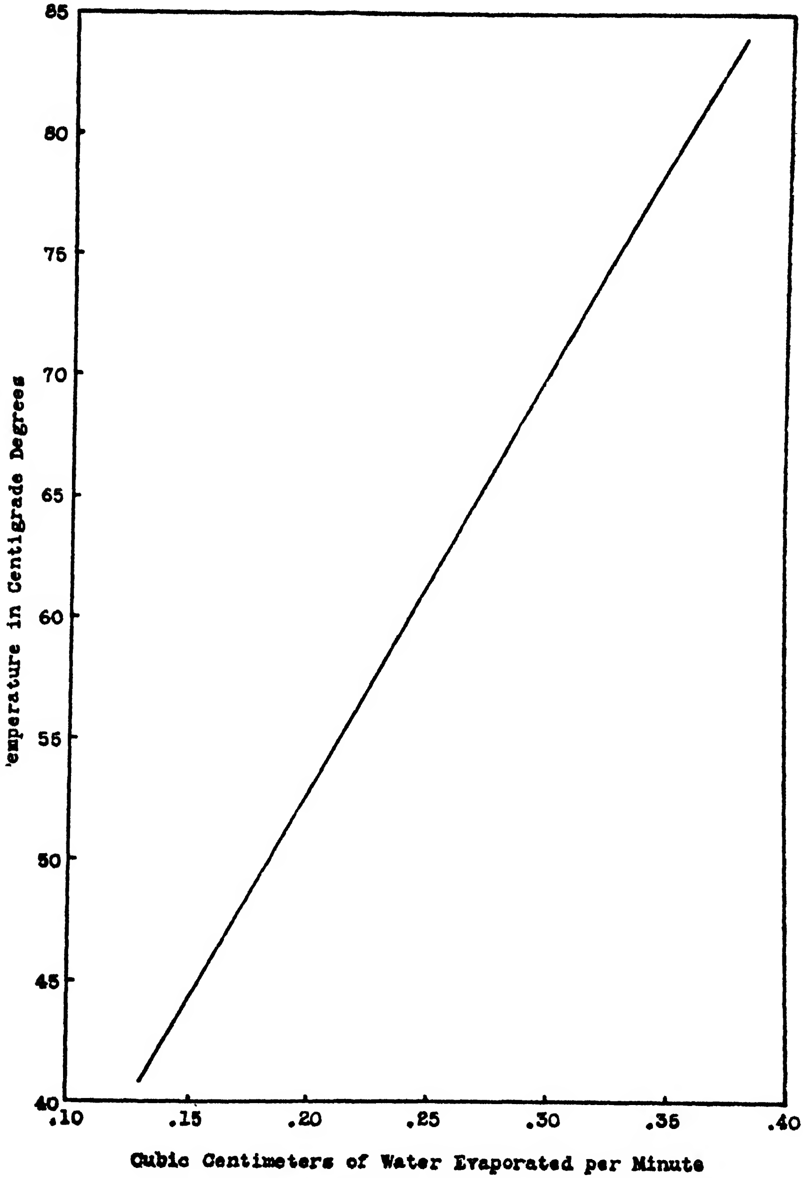


Fig. 2. The number of cubic centimeters of water evaporated per minute from an atmometer, plotted against the temperature in Centigrade degrees. The determinations were made at 10° intervals. The figures in table II relating to the evaporation rate were taken from this graph.

and growing tip was injured. Therefore, the lower critical temperature of the seedlings can be attributed to the lack of resistance of the hypocotyl and not to the injuring of meristematic regions.

TABLE I

COTTON SEEDLINGS TREATED AT THE LOWER RELATIVE HUMIDITY

Temp. in degrees C.	Time	Age of plants (days)	Number of plants	Number living	Number dead	Evap. rate (cc. per min.)*
42	72 hr.	10	12	12		.14
45	45 hr.	24	9	6		.15
47	26 hr.	9	15	15		.16
52	3 hr.	10	12	12		.19
54	10 min.	8	32	32		.21
54	15 min.	8	6	1	5	
54	20 min.	8	10	4	6	
54	45 min.	8	20		20	
56	2½ min.	8	11	11		.22
56	5 min.	8	10	10		
56	7½ min.	8	10		10	
56	10 min.	8	8		8	
57	15 min.	8	40	1	39	.22
57	20 min.	10	20	8	12	
57	35 min.	8	66		66	
60	5 min.	10	15	15		.25
60	8 min.	8	55		55	
63	5 min.	8	65		65	.26
65	1 min.	10	17	17		.27
65	2½ min.	10	15	6	9	
65	5 min.	10	29		29	
67	1 min.	8	21	18	3	.28
68	1 min.	10	10	10		.29
68	2 min.	10	40		40	
69	1 min.	10	10	8	2	.29
69	2 min.	10	9		9	
70	1 min.	10	6	1	5	.30
70	2 min.	10	6	4	2	
70	4 min.	10	8		8	
74	1 min.	10	10	2	8	.32
74	1½ min.	10	21		21	
75	1 min.	10	4		4	.33
77	1 min.	10	11	1	10	.34
78	1 min.	10	6		6	.35
80	1 min.	10	11	3	8	.36

*This column shows the evaporation rate of water in cubic centimeters per minute from an atmometer, as described under "Apparatus," for the temperatures indicated.

In order to determine the cause of this differential resistance of the hypocotyls and cotyledons an experiment was made to find the amount of water lost during treatment and during various periods of time following treatment. This was done by deter-

TABLE II

COTTON PLANTS FROM 16 TO 180 DAYS OLD TREATED AT THE LOWER HUMIDITY

Temp. in degrees C.	Time	Age of plants (days)	Number of plants	Number living	Number dead	Evap. rate (cc. per min.)*
42	24 hr.	25	6	6		.14
42	48 hr.	16	18	12	6	
42	72 hr.	53	6	4	2	
45	2 hr.	76	6	6		.15
47	18 hr.	77	36	36		.16
47	26 hr.	19	14	11	3	
47	26 hr.	76	6	6		
50	1½ hr.	35	12	10	2	.18
50	2¼ hr.	35	12	3	9	
52	3¾ hr.	55	48		48	.19
52	6 hr.	25	12	9	3	
53	1 hr.	78	28	28		.20
54	1 hr.	23	12	12		.21
55	30 min.	70	19	3	16	.21
55	30 min.	180	2	2		
55	45 min.	60	10	8	2	
55	1 hr.	24	18		18	
60	3 min.	32	11	4	7	.24
60	15 min.	70	25	5	20	
60	20 min.	70	27	2	25	
60	25 min.	30	55		55	
61	5 min.	32	16	4	12	.25
61	20 min.	32	128		128	
62	3 min.	32	7	3	4	.25
62	8 min.	32	10	2	8	
62	10 min.	32	50		50	
63	5 min.	72	14	2	12	.26
63	7 min.	72	18		18	
64	5 min.	32	82		82	.26
65	1 min.	40	8	8		.27
65	2 min.	40	8	4	4	
65	4 min.	40	113		113	
68	3 min.	40	73		73	.29
70	2 min.	70	16	2	14	.30
70	2½ min.	60	20		20	
70	3 min.	70	13		13	
74	1 min.	40	11	6	5	.32
74	1 min.	70	7	2	5	
74	1½ min.	40	11	1	10	
74	2 min.	40	10		10	
78	1 min.	40	11	2	9	.34
78	1 min.	70	4	3	1	
78	1 min.	120	3	2	1	
78	1½ min.	40	29		29	
80	1 min.	40	8	2	6	.36
80	1 min.	70	10	5	5	
80	1½ min.	60	32		32	
82	1 min.	70	8	2	6	.37
84	½ min.	70	7	5	2	.38
84	1 min.	70	11	1	10	
84	1¼ min.	60	10		10	

*This column shows the evaporation rate of water in cubic centimeters per minute from an atmometer, as described under "Apparatus," for the temperatures indicated.

mining the average percentage of moisture in the hypocotyls and cotyledons of treated and untreated seedlings (table III). The treated seedlings had been exposed for 15 minutes to a temperature of 60° C., a treatment known to leave the cotyledons of most of the seedlings in a living condition for a week or ten days.

In all, five sets were run: in one, which was used as a control, the plants were weighed before treatment, in one they were weighed immediately after treatment, in one, after 2 hours, in one, after 24 hours, and in another, 96 hours after treatment. Before weighing, the seedlings were cut about one-half inch above the surface of the soil and again immediately below the junction of the cotyledons and the hypocotyls. The hypocotyls and cotyledons were weighed separately, dried, and reweighed.

The results (table III) show that the hypocotyls and cotyledons had approximately the same water content before treatment, but the cotyledons lost considerably more during the treatment (3.3 per cent loss in the cotyledons as compared with 0.2 per cent in the hypocotyls). During the first 2 hours the cotyledons still showed a slightly more rapid rate of loss than the hypocotyls, but after 24 hours they had regained more than 3 per cent, while the hypocotyls still continued to lose. After 96 hours the hypocotyls were very much withered, having an average of only 78.3 per cent moisture, while the cotyledons still retained an average of 87.4 per cent and were more or less turgid.

TABLE III

LOSS OF MOISTURE IN SEEDLINGS DURING AND AFTER TREATMENT AT 60° C. FOR 15 MINUTES AT LOW RELATIVE HUMIDITY

Number of plants		Per cent loss of moisture in hypocotyls	Per cent loss of moisture in cotyledons
400	Untreated	92.2	92.1
200	Treated & weighed immediately	92.0	88.8
200	Weighed 2 hours after treatment	91.1	87.7
200	Weighed 24 hours after treatment	88.2	90.8
200	Weighed 96 hours after treatment	78.3	87.4

SERIES II

High humidity.—Under the high humidity conditions also the seedlings showed a somewhat lower and more variable critical temperature than did the older plants. When first removed from the temperature chamber, neither the seedlings nor the

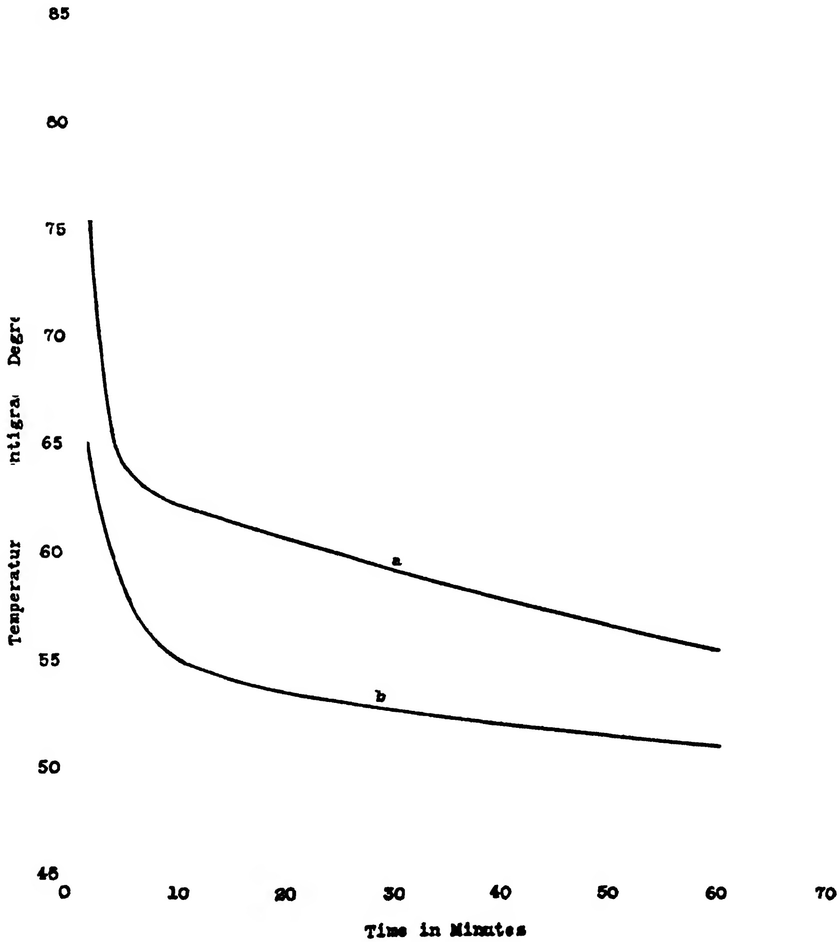


Fig. 3. The time in minutes necessary to kill all plants, plotted against the temperature in Centigrade degrees. The line (a) shows the results of the lower relative humidity experiments and (b) the results of the higher. Note the sharp break in (a). The lines in this graph are not drawn through any definite set of points but are plotted from tables II and V and are based upon the results obtained from the treatment of more than 4000 plants.

older plants showed any evidences of injury unless they had been left in the chamber for a period of time considerably longer than was necessary to kill them. In such a case, the young leaves and cotyledons appeared as if scalded. In the seedlings, injurious effects were later evidenced by the wilting or withering of the

TABLE IV

COTTON SEEDLINGS TREATED AT APPROXIMATELY 100 PER CENT RELATIVE HUMIDITY

Temp. in degrees C.	Time	Age of plants (days)	Number of plants	Number living	Number dead
41	24 hr.	12	22	4	18
41	48 hr.	13	22		22
42	9 hr.	10	6		6
45	2 hr.	10	6	6	
50	30 min.	14	12	2	10
50	45 min.	14	21	4	17
50	60 min.	14	24	8	16
52	10 min.	8	11	9	2
53	5 min.	15	6	6	
53	10 min.	9	6		6
54	3 min.	8	21	20	1
54	5 min.	8	15	6	9
55	5 min.	8	48	25	23
55	7 min.	8	23		23
57	2 min.	8	14	14	
57	3 min.	8	15	8	7
57	4 min.	8	15	2	13
58	2 min.	8	25	15	10
58	3 min.	8	16	3	13
58	5 min.	8	20		20
59	3 min.	8	23	1	22
59	5 min.	8	14		14
60	1 min.	8	8	8	
60	2 min.	8	22	12	10
60	2½ min.	8	40		40
61	2 min.	8	79		79
62	½ min.	8	9	9	
62	¾ min.	8	14		14
62	1 min.	8	37	3	34
62	2 min.	8	24		24
63	¾ min.	8	45		45
64	½ min.	8	54		54
65	½ min.	8	28		28

cotyledons, followed either by their abscission or by the drying up of the whole plant, the amount of injury and the time of its appearance depending upon the severity of the treatment. In older plants, injury appeared in the form of flaccidly wilted leaves and blackened growing tips which proved to be dead. In all cases, the growing tips were more resistant than the leaves, and even when the growing tips were killed secondary growth often appeared at the nodes. There was no withering of the hypocotyls and petioles (the cotyledons and leaves remaining green) as described for the lower humidity experiments.

Tables IV and V and fig. 3b give the detailed results of the higher humidity experiments. It will be noted from the tables and particularly from the figure that plants of any given age were much less resistant to high temperatures in the saturated atmosphere than at the lower humidity. The thermal death temperature evidently lies in the neighborhood of 55° C., if a definite point can be determined from this curve. This is 8° C. below that shown by the plants treated at the lower humidity.

TABLE V

COTTON PLANTS FROM 18 TO 120 DAYS OLD TREATED AT APPROXIMATELY 100 PER CENT RELATIVE HUMIDITY

Temp. in degrees C.	Time	Age of plants (days)	Number of plants	Number living	Number dead	Secondary growth*
40	7 hr.	18	8	5	3	
40	10 hr.	19	30	7	23	
40	12 hr.	19	6		6	
41	24 hr.	50	30	24	6	
41	72 hr.	50	6	2	4	
42	9 hr.	35	26	26		
45	2 hr.	40	18	18		
46	2 hr.	18	12	12		
48	20 min.	26	6	6		
48	40 min.	26	6	5	1	
48	1 hr.	26	6	2	4	
48	1¼ hr.	26	6	3	3	
48	1¾ hr.	26	38		38	
50	30 min.	77	14	11	3	
50	45 min.	77	19	13	6	6
50	1 hr.	77	38	17	19	19
52	10 min.	72	11	11		
53	5 min.	26	6	1	5	
53	5 min.	36	6	3	3	
53	10 min.	35	102		102	
54	3 min.	72	11	11		
54	5 min.	70	4	2	2	2

TABLE V—Continued

Temp. in degrees C.	Time	Age of plants (days)	Number of plants	Number living	Number dead	Secondary growth*
54	10 min.	50	55		55	
55	3 min.	30	18	2	16	
55	5 min.	120	2	2		
55	7 min.	72	10	10		
55	9 min.	60	8		8	
56	5 min.	72	28	7	21	5
57	2 min.	73	2	1	1	1
57	4 min.	73	4		4	2
58	2 min.	73	7	3	4	
58	3 min.	70	4	3	1	1
58	4 min.	70	16	12	4	
58	5 min.	60	15		15	
59	2 min.	70	6	1	5	4
59	3 min.	70	5		5	
59	5 min.	73	11	1	10	
60	1 min.	73	1	1		
60	2½ min.	120	3	3		
60	3 min.	73	15	6	9	2
60	4 min.	60	9		9	
61	1½ min.	75	3	1	2	
61	2 min.	73	10		10	
62	½ min.	73	5	5		
62	¾ min.	73	8	5	3	2
62	1 min.	73	26	2	24	3
62	2 min.	72	8	5	3	2
62	2½ min.	60	10		10	
62	3 min.	72	11		11	3
63	¾ min.	73	6		6	4
63	1 min.	73	3	1	2	
63	1¼ min.	73	4		4	1
64	½ min.	73	9		9	4
64	1 min.	73	12		12	3
65	½ min.	73	2	2		
65	¾ min.	73	6	1	5	4
65	1 min.	73	5	2	3	
65	1¼ min.	60	10		10	

*This column shows the number of plants that put forth secondary growth at the nodes after the growing tips had been killed.

DISCUSSION

When the data of the two sets of plants were compared, it was found that the cotton plant was much more resistant to high temperatures under the lower-humidity conditions. Furthermore, the nature of the injury and the parts of the plant first to be affected were entirely different in the two sets. At the lower relative humidity, the petioles, young stems, and the hypocotyls were the first to be killed, whereas at the higher relative humidity they were the last to be affected, the leaves and cotyledons

dying first. The seedlings treated at the lower relative humidity were invariably killed by injury to the hypocotyls.

Experiments showed that the cotyledons of the seedlings treated at the lower relative humidity lost moisture at a much greater rate than the hypocotyls during the treatment. Immediately following their removal from the temperature chamber the hypocotyls lost moisture rapidly while the cotyledons regained a large percentage of that lost during treatment. This would indicate that the evaporation of the water immediately utilized enough of the heat energy around the leaves and cotyledons to protect them until the other portions became injured and even killed. This assumption is further substantiated by the fact that all plants were so readily killed in the saturated atmosphere where transpiration was reduced to a minimum.

These experiments tend to prove the statement first made by Sachs ('64) and later by Ewart ('03) and Baker ('29) that reduced transpiration allows a more rapid concentration of heat in the plant. This phenomenon has not been emphasized by sufficient experimental data to show its true significance, and apparently not in any case has it been previously demonstrated under the conditions of thermal death temperatures. Clum ('26) claimed that this cooling effect was greatly over-estimated, but his experiments on thermal death temperatures were not sufficiently well controlled to justify his statement.

In the light of the facts shown by the present experiments it is evident that the thermal death point has not as yet been clearly defined. It will be necessary to limit the term to the death of the protoplasm alone and not to the entire plant. The death of the plant might be caused by the injuring or killing of some portion or organ which would prevent normal functioning, as shown by the seedlings treated at the lower relative humidity.

Local injury which is not outwardly evidenced may occur at temperatures below that designated as the thermal death temperature. Litardière ('25), working with onion root tips, found that the nuclei were affected at 48° C. after 24 hours and that the injury increased with higher temperatures even for shorter periods of time. Yamaha ('27) gave 38° C. as a critical temperature for the root tips of the bean, and Milovidov ('32), working

with a number of different plants, found that temperatures around 45–47° C. were injurious to the plants studied if the treatment were prolonged. The cursory microscopic studies made on the cotton plants in the present work showed that temperatures of 55° C. and above, even for very short periods of time, were injurious to the protoplasm, causing plasmolysis and deformation of the nuclei. Since these were not uniformly distributed in the plant it would be difficult to estimate their ultimate effects.

Blackman's idea of the "extinction temperature"[1] ('05) necessitates the setting of an arbitrary time limit which, in the opinion of the writers, is not justified since the time required for the protoplasm itself to assume the thermal death temperature would vary with atmospheric conditions under which the plants were treated.

At present no entirely satisfactory definition of the thermal death point can be given, but the following may serve until more data is available: *The thermal death point is that temperature which, at a given relative humidity, will kill the protoplasm immediately upon its assumption.* Were it not for the indication that humidity has an effect in addition to preventing cooling caused by the retardation of the transpiration rate, it would be possible to eliminate from the definition the qualifying phrase dealing with humidity. If the humidity had no other effects it would merely vary the time required for the plant cells to assume the temperature necessary to kill the protoplasm. This does not appear to be the fact, however, since there is so much difference between the low- and high-humidity experiments. It is likely that the extremely high relative humidity has an additional effect, that of smothering the plants. When plants from an atmospheric temperature of 25–30° C. were abruptly transferred into a temperature of 50–60° C. and a practically saturated atmosphere, condensation immediately took place on the surface of the leaves and stems. By reducing the transpiration stream

[1] " . . . we ought to find a temperature at which the earliest estimation that could be actually made would give no measurable assimilation. The lowest temperature to give this result might be called the 'extinction temperature' . . . (say in 100 seconds, for the accepted specific extinction temperature would of course have to be arbitrarily defined in time units)."

and the usual exchange of gases, this film of water would naturally limit the oxygen supply of the plant. Since plants in the higher temperature would demand more oxygen than could be obtained, it is possible that the protoplasm was killed by a combination of factors. The evaluation of the extent and full importance of this smothering effect will necessitate further experimentation.

In regard to the time limit as a criterion of the thermal death point, we must consider the factors influencing the rapid change of temperature of the plants from that of the atmosphere in which they were grown to that of the treating chamber. Some of these factors are transpiration in the plant, condensation of moisture on its surface, and temperature gradients immediately around the plants. Temperature gradients can be prevented by keeping the air thoroughly mixed, but it is very difficult to determine the exact relations of transpiration or condensation and the change in temperature of the protoplasm.

An examination of fig. 3a shows a sharp break in the line between 60 and 65° C., which marks the critical temperature for the cotton plant at the low relative humidity. A thermal death temperature of 63° C. may then be chosen, but that is the temperature of the atmosphere. It will be noted that it took from 5 to 7 minutes to kill the plants at 63° C. and progressively shorter intervals of time as the temperature increased, which would indicate that the protoplasm died immediately upon assuming the temperature of the atmosphere. The time lag, caused primarily by the cooling effect of transpiration, makes it necessary either to determine the exact temperature of the protoplasm or, more simply, to plot the temperature against the time and determine from the graph thus obtained the approximate thermal death point.

It is true that prolonged temperatures below 63° C. will kill the plants, but it is also evident from the slope of the upper portion of the line that it did not take, for example, 25 minutes for the protoplasm to assume a temperature of 60° C. when treated at this temperature. Then they were killed gradually, and in such a case the reactions set up by the high temperatures may have led to the death of the protoplasm.

It may be concluded that no definite temperature can be set

as the thermal death point of the cotton plant without stating first the atmospheric conditions under which the plants were treated and giving the ages of the plants. Transpiration plays a definite role in the cooling of the leaves and cotyledons under low relative humidity conditions.

SUMMARY

1. Two series of cotton plants 5 to 180 days old were exposed to super optimal and thermal death temperatures for periods of time ranging from ½ minute to 72 hours. In Series I the plants were exposed to temperatures of 42–84° C. at an average relative humidity of 69 per cent at temperatures below 50° C. The evaporation rate was substituted for relative humidity in this series. In series II the plants were exposed to temperatures of 40–65° C. at an approximately saturated atmosphere.

2. Seedlings were less resistant to high temperatures at any given relative humidity than older plants.

3. The plants were less resistant to high temperatures at the higher relative humidity.

4. At the higher relative humidity, the leaves and cotyledons were the first parts of the plant to be affected.

5. At the lower relative humidity, the hypocotyls of the seedlings and the petioles and young stems of the older plants were the first to be affected.

6. During treatment at the lower humidity, the cotyledons lost water rapidly whereas the hypocotyls lost very little. After removal from the treating chamber the cotyledons regained a large percentage of the water lost and became turgid again, whereas the hypocotyls continued to lose moisture until they were completely withered.

7. The more rapid rate of transpiration in the cotyledons apparently utilized sufficient heat energy to protect them from being noticeably injured until the hypocotyls were killed. These data tend to substantiate the theory that the cooling effect of transpiration is of great value to plants in preventing an accumulation of heat energy.

8. The saturated atmosphere of Series II appeared to have an additional effect, that of smothering the plants. This was

apparently due to the retardation of the gas exchange caused by the condensation of moisture on the surface of the plants, thus reducing the oxygen supply.

9. Due to the two-fold effects of humidity the following is given as a tentative definition of the thermal death point: The thermal death point is that temperature which, at a given relative humidity, will kill the protoplasm immediately upon its assumption.

10. No definite temperature can be given as the thermal death point of the cotton plant without stating the humidity of the atmosphere and the age of the plant.

The writers wish to express their appreciation to Dr. E. S. Reynolds, Physiologist to the Missouri Botanical Garden, for suggestions and criticisms given during the progress of the work.

BIBLIOGRAPHY

Baker, F. S. ('29). Effects of excessively high temperatures on coniferous reproduction. Jour. Forest. **27**: 949–975. 1929.

Berkley, E. E. ('31). Studies of the effects of different lengths of day, with variations in temperature, on vegetative growth and reproduction in cotton. Ann. Mo. Bot. Gard. **18**: 573–604. 1931.

Blackman, V. H. ('05). Optima and limiting factors. Ann. Bot. **19**: 281–295. 1905.

Bose, J. C. ('13). Researches on irritability of plants. Longmans, Green and Co., 1925.

Clum, H. H. ('26). The effect of transpiration and environmental factors on leaf temperatures. I. Transpiration. Am. Jour. Bot. **13**: 194–216. 1926.

————, ('26). The effect of transpiration and environmental factors on leaf temperatures. II. Light intensity and the relation of transpiration to the thermal death point. *Ibid.* **13**: 217–230. 1926.

Collander, R. ('24). Beobachtungen über die quantitativen Beziehungen zwischen Tötungsgeschwindigkeit und Temperatur beim Wärmetod pflanzlicher Zellen. Soc. Sci. Fennica, Comment. Biolog. **1**: 1–12. 1924.

Ewart, A. J. ('03). On the physics and physiology of protoplasmic streaming in plants. pp. 59–68. Oxford, 1903.

Fung, H. K. ('11). An ecological study of the American cotton plant with incidental reference to its possible adaptability in China. An unpublished doctor's thesis of Cornell University. June, 1911.

Gilbert, B. E. ('26). The response of certain photoperiodic plants to differing temperature and humidity conditions. Ann. Bot. **40**: 315–320. 1926.

Lepeschkin, W. ('25). Pflanzenphysiologie. Julius Springer, Berlin, 1925.

Litardière, R. de ('25). Les diverses étapes de l' "agonie" des noyaux sous l'influence d'une température élevée. Soc. Biol., Compt. Rend. **92**: 796–798. 1925.

Milovidov, P. F. ('32). Einfluss von Wasser hoher Temperatur auf den Kern der Pflanzenzellen im Lichte der Nuklealreaktion. Protoplasma **17**: 32–88. 1932.

Pfeffer, W. F. P. ('03). Physiology of plants **2**: 224–231. Eng. ed. 1903.

Sachs, J. ('63). Die vorübergehenden Starre-Zustände periodisch beweglicher und reizbarer Pflanzenorgane. Flora **46**: 449–459. 1863.

————, ('64). Über die obere Temperatur-gränze der Vegetation. *Ibid.* **47**: 5–12. 1864.

Wallace, R. H. ('31). Studies on the sensitivity of *Mimosa pudica.* III. The effect of temperature, humidity and certain other factors upon seismonic sensitivity. Am. Jour. Bot. **18**: 288–307. 1931.

Yamaha, G. ('27). Experimentelle zytologische Beiträge. II. Mitteilung. Über die Wirkung des destillierten Wassers auf die Wurzelspitzenzellen von *Vicia Faba* bei verschiedenen Temperaturen. Imp. Univ. Tokyo, Jour. Fac. Sci. **2**: 215–296. 1927.

STUDIES IN THE APOCYNACEAE. IV

The American Genera of Echitoideae

ROBERT E. WOODSON, JR.

Research Assistant, Missouri Botanical Garden
Instructor in Botany, Henry Shaw School of Botany of Washington University

Introduction

Because of their diverse and highly complicated floral mechanism, the American genera of the subfamily Echitoideae are at present perhaps the most imperfectly understood of Apocynaceae. As in pre-Linnean and early post-Linnean times laticiferous herbs of several distinct affinities were grouped indiscriminately under the name "Apocynum," so even to-day practically any echitoid liana indigenous to the western hemisphere may pass as a species of the inclusive genus *Echites* P. Br., although several excellent genera have been segregated from that amorphous and heterogeneous aggregate by Bentham, Robert Brown, Alphonse de Candolle, Mueller-Argoviensis, and other eminent systematists. To the less exacting botanical public, however, *Echites* has remained a convenient catch-all, and species of very dubious congenericity have been described and redescribed under that name until the literature has become so involved that it is a dangerous task to attempt routine determinative work, and much more so to essay the description of novelties.

The Apocynaceae of the western hemisphere attain their greatest complexity in tropical South America. Although monographic work hinting of any degree of finality upon most groups of tropical American plants had best be deferred for the future because of the incomplete state of our knowledge concerning the flora of that region, constant exploration in behalf of varied interests is bringing to the attention of science increasing multitudes of plants which must be critically identified by the systematic botanist. In order to facilitate that activity and to render the results more sure with respect to the numerous representatives of Apocynaceae, it has been considered highly desirable to undertake at this time a tentative revision of the troublesome Echitoideae.

Issued December 19, 1933.

The most perplexing problem, as well as that first encountered in the course of such a revision, as has already been intimated, concerns generic relationships. The first requirement of a revision of the American Echitoideae should be the careful delimitation of the genera most deserving of recognition, and their epitomization in the form of an identificatory key. The second problem, of necessity wholly dependent upon the first, is that of a separate revision of each genus maintained within the subfamily.

In order to judge and to correlate more competently the numerous genera which have been proposed from time to time, the morphology of certain critical vegetative and floral organs has been investigated and interpreted in separate reports which are in preparation for publication in the near future. Only a brief account of the structural features employed as classificatory criteria is included here as an aid in the use of both generic and specific keys. It may be well to point out at this time that the limits of the subfamily Echitoideae as accepted in this instance are those established in the first paper of this series[1] to the exclusion of the genera of Apocynoideae characterized by pollen maintained within persistent tetrads.

For the purely taxonomic portion of the revision, recourse has been had to the extensive collections of most of the principal herbaria of America and Europe. Since it is believed that such inclusions generally enhance the value of taxonomic studies, exsiccatae have been freely cited, particularly in the instance of difficult or little-known species. The herbaria where specimens have been examined or obtained for study, together with the symbols employed in their citation, are as follows: Arnold Arboretum of Harvard University, Jamaica Plain (AA); Botanischer Garten zu Berlin-Dahlem (B); Museo Nacional de Buenos Aires (BA); Herbier Boissier, Institut Botanique de l'Université, Geneva (BB); British Museum (Natural History), London (BM); Jardin Botanique de l'État, Brussels (Bx); Botanisk Museum, Copenhagen (C); California Academy of Sciences, San Francisco (CA); Lindley Herbarium, Botany School, Cambridge, Engl. (Camb.); Delessert (D) and de Candolle (DC) herbaria, Con-

[1] Woodson, R. E., Jr. Ann. Mo. Bot. Gard. 17: 9. 1930.

servatoire Botanique, Geneva; Field Museum of Natural History, Chicago (FM); Gray Herbarium of Harvard University, Cambridge, Mass. (G); Royal Botanic Gardens, Kew (K); Linnaean Society of London (Linn.); Dudley Herbarium, Leland Stanford Junior University, Palo Alto (LS); Botanisches Museum, Munich (M); Missouri Botanical Garden, St. Louis (MBG); Museo Comercial de Venezuela, Caracas (MC); Muséum National de l'Histoire Naturelle, Paris (MP); New York Botanical Garden, New York City (NY); Academy of Natural Sciences of Philadelphia (PA); Pomona College, Claremont (PC); Naturhistoriska Riksmuseum, Stockholm (S); Botanisch Museum, Rijks Universiteit, Utrecht (U); University of California, Berkeley (UC); United States National Herbarium, Washington (US); Naturhistorisches Museum, Vienna (V). To the curators and members of the staff of these institutions, as well as to many other friends, the writer would express his gratitude for innumerable instances of aid and good will. He is also greatly indebted to the Board of Trustees and to the Director of the Missouri Botanical Garden for the privilege of a trip to Central America in 1930 for observation and study.

Historical Review

None of the species which are now comprised within the American genera of Echitoideae was known to Linnaeus at the time of publication of the first edition of the 'Species Plantarum' in 1753 or of the fifth edition of the 'Genera Plantarum' the year following. In 1756, however, Patrick Browne[2] inaugurated the genus *Echites*, citing rather full distinguishing characters, but failed to assign a binomial species. The single polynomial referred to the genus by Browne, "*Echites foliis ovatis nitidis venosis; floribus herbaceis*," was founded upon a plant well illustrated by Sir Hans Sloane,[3] and quite clearly establishes the common species of the Greater Antilles, the Bahamas, the peninsula of Yucatan, and southern peninsular Florida, *E. umbellata* Jacq., as the type of the genus as we shall deal with it here.

[2] P. Br. Hist. Jam. 182. 1756.

[3] "*Apocynum scandens majus, folio subrotundo,*" Sloane, Nat. Hist. Jam. 1: 207. *pl. 131, fig. 2.* 1707.

The monotypic genus *Echites* as defined by Browne was interpreted by Linnaeus[4] in the tenth edition of the 'Systema' merely as constituting a species of *Tabernaemontana,* and the former generic name was employed as a substantive adjective.

Four years after its first publication, the genus *Echites* was expanded by Jacquin[5] to include ten species: *E. biflora, E. umbellata, E. agglutinata, E. trifida, E. quinquangularis, E. suberecta, E. torosa, E. repens, E. spicata,* and *E. corymbosa.* In 1763, Jacquin[6] maintained the species which he had described three years previously, illustrating each in an admirable manner. Of the ten enumerated, which are now distributed among nine well-known genera, all but three were original. For *E. umbellata,* Jacquin[7] was able to cite four pre-existing polynomials, two for *E. suberecta,*[8] and one each for *E. torosa,*[9] and *E. biflora.*[10]

In the second edition of the 'Species Plantarum' Linnaeus[11] included *Echites* within the "Pentandria Monogynia," and appended the ten species of Jacquin. Two years subsequently the genus also appeared in the sixth edition of the 'Genera Plantarum.'[12]

It would be a weary task to record in detail the great enlargement of the genus *Echites,* which almost immediately followed its original publication, to include scores of Apocynaceous species of the subfamily Echitoideae native to nearly all parts of the

[4] L. Syst. Nat. ed. 10. 945. 1759.

[5] Jacq. Enum. Syst. Pl. Carib. 13. 1760.

[6] *Ibid.* Select. Stirp. Am. Hist. 1: 30–35; 2: *pls. 21–30.* 1763.

[7] "*Echites scandens foliis ovatis nitidis venosis; floribus herbaceis,*" P. Br. Hist. Jam. 182. 1756; "*Apocynum scandens folio cordato, flore albo,*" Catesb. Nat. Hist. Carol. 1: 58. *pl. 58.* 1754; "*Apocynum scandens majus, folio subrotundo,*" Sloane, Nat. Hist. Jam. 1: 207. *pl. 131, fig. 2.* 1707; "*Periploca alia, floribus amplis circinatis & crispis, seu Nerium scandens, radice Bryoniae tuberosae,*" Plum. Pl. Am. 210. *pl. 216, fig. 2.* 1759.

[8] "*Apocynum scandens, amplo flore villoso, luteo, siliquis angustissimis,*" Plum. Cat. Pl. Am. 2. 1703; "*Apocynum erectum, fruticosum, flore luteo maximo & speciosissimo,*" Sloane, Nat. Hist. Jam. 1: 206. *pl. 130, fig. 2.* 1707.—The former appears to apply somewhat more obviously to *E. biflora* Jacq.

[9] "*Nerium sarmentosum, scandens, ramulis tenuibus, folliculis gracilibus torosis,*" P. Br. Hist. Jam. 181. *pl. 16, fig. 2.* 1756.

[10] "*Apocynum scandens, flore nerii albo,*" Plum. Descr. Pl. Am. 82. *pl. 96.* 1693.

[11] L. Sp. Pl. ed. 2. 307. 1762.

[12] L. Gen. Pl. ed. 6. 117. 1764.

world.[13] The result was soon so obviously conglomerate that in 1811, in his treatise "On the Apocineae," Robert Brown[14] recommended the limitation of the generic name to the species of the western hemisphere, distinctly citing *E. umbellata* Jacq. as the original species. Although, unfortunately, he did not attempt to redefine the characters of *Echites*, Brown described in the same work[15] the genus *Prestonia*, which is therefore the second of the American genera of Echitoideae in point of age.

Since 1811, the publication of American genera of the subfamily Echitoideae has constantly augmented. Summarized chronologically in tabular form, the appearance of genera from 1756 until the present has been as follows:

1756	*Echites* P. Br. Hist. Jam. 182. 1756; Jacq. Enum. Syst. Pl. Carib. 13. 1760.
1811	*Prestonia* R. Br. Mem. Wern. Soc. 1: 69. 1811.
1818	*Forsteronia* G. F. W. Mey. Fl. Esseq. 133. 1818.
1819	*Thenardia* HBK. Nov. Gen. 3: 209. 1819.
1825	*Haemadictyon* Lindl. Trans. Hort. Soc. Lond. 6: 70. 1825.
1828	*Syringosma* Mart. ex Rchb. Consp. 134. 1828.
1838	*Exothostemon* G. Don, Gen. Hist. Dichlam. Pl. 4: 82. 1838.
1840	*Mandevilla* Lindl. Bot. Reg. N. S. 3: *pl. 7.* 1840.
1841	*Odontadenia* Benth. in Hook. Jour. Bot. 3: 242. 1841.
	Thyrsanthus Benth. loc. cit. 245. 1841.
1844	*Malouetia* A. DC. in DC. Prodr. 8: 378. 1844.
	Anisolobus A. DC. loc. cit. 395. 1844.
	Robbia A. DC. loc. cit. 444. 1844.
	Secondatia A. DC. loc. cit. 445. 1844.
	Laseguea A. DC. loc. cit. 481. 1844.
	Dipladenia A. DC. loc. cit. 1844.
	Laubertia A. DC. loc. cit. 486. 1844.
1849	*Cycladenia* Benth. Pl. Hartw. 322. 1849.
1855	*Cylicadenia* Lem. Illustr. Hort. 2: Misc. 9. 1855.
1860	*Heterothrix* Muell.-Arg. in Martius, Fl. Bras. 6^1: 133. 1860.

[13] Cf. Stadelm. Flora 24^1: Beibl. 1–13. 1841.
[14] R. Br. Mem. Wern. Soc. 1: 59. 1811.
[15] *Ibid. loc. cit.* 69. 1811.

Macrosiphonia Muell.-Arg. loc. cit. 137. 1860.
Amblyanthera Muell.-Arg. loc. cit. 141. 1860, not Blume.
Mesechites Muell.-Arg. loc. cit. 150. 1860.
Rhodocalyx Muell.-Arg. loc. cit. 172. 1860.
Rhabdadenia Muell.-Arg. loc. cit. 173. 1860.
Stipecoma Muell.-Arg. loc. cit. 175. 1860.
Elytropus Muell.-Arg. Bot. Zeit. **18**: 21. 1860.
Prestoniopsis Muell.-Arg. loc. cit. 22. 1860.
Urechites Muell.-Arg. loc. cit. 22. 1860.

1878 *Chariomma* Miers, Apoc. So. Am. 110. 1878.
Eriadenia Miers, loc. cit. 117. 1878.
Aptotheca Miers, loc. cit. 150. 1878.
Rhaptocarpus Miers, loc. cit. 151. 1878.
Micradenia Miers, loc. cit. 158. 1878.
Homaladenia Miers, loc. cit. 163. 1878.
Angadenia Miers, loc. cit. 173. 1878.
Perictenia Miers, loc. cit. 182. 1878.
Temnadenia Miers, loc. cit. 207. 1878.
Mitozus Miers, loc. cit. 217. 1878.

1897 *Streptotrachelus* Greenm. Proc. Am. Acad. **32**: 298. 1897.

1905 *Bracea* Britton, Bull. N. Y. Bot. Gard. **3**: 448. 1905, not King.

1909 *Orthechites* Urb. Symb. Ant. **6**: 36. 1909.

1917 *Belandra* S. F. Blake, Contr. Gray Herb. N. S. **52**: 78. 1917.

1920 *Neobracea* Britton, in Britton & Millsp. Bahama Fl. 335. 1920.

1924 *Codonechites* Mgf. Notizblatt **9**: 80. 1924.

1927 *Macropharynx* Rusby, Mem. N. Y. Bot. Gard. **7**: 327. 1927.

1931 *Salpinctes* Woodson, in Gleason, Bull. Torrey Bot. Club **58**: 453. 1931.

1932 *Allomarkgrafia* Woodson, Ann. Mo. Bot. Gard. **19**: 45. 1932.
Asketanthera Woodson, loc. cit. 46. 1932.
Fernaldia Woodson, loc. cit. 48. 1932.

Galactophora Woodson, loc. cit. 49. 1932.
Peltastes Woodson, loc. cit. 375. 1932.

An interesting if frequently perplexing feature shared in common by many species of the majority of genera enumerated is their persistent popular association with the parent genus *Echites* within which they were once included. Perhaps the highest attainment of the research upon the Apocynaceae of Alphonse de Candolle and particularly of Mueller-Argoviensis was the distillation of the American representation of the inclusive genus *Echites* into numerous more natural entities. Unfortunately, the painstaking studies of those eminent systematists was discredited to a certain degree by the contemporaneous treatment of John Miers which has discouraged the employment of the valid segregates by confounding with them a miscellaneous assortment of incongruous species and genera.

The revision of the Apocynaceae under the authorship of K. Schumann[16] in Engler & Prantl's 'Natürlichen Pflanzenfamilien' has helped to reclarify the status of the American Echitoideae, but has suffered as a result of the acceptance of Miers's mistaken interpretations in several instances. Schumann unfortunately profited little by the excellent natural order given the genera of the subfamily by Mueller, and as a consequence in his enumeration one finds *Eriadenia* Miers and *Mandevilla* Lindl., considered as synonymous by Markgraf[17] and in the present revision, separated by such discrepant genera as *Macrosiphonia* Muell.-Arg., *Rhodocalyx* Muell.-Arg., *Cycladenia* Benth., *Dipladenia* A. DC., *Odontadenia* Benth., *Elytropus* Muell.-Arg., *Rhabdadenia* Muell.-Arg., and *Laubertia* A. DC., in the order named. This situation is the result of the key characters employed by Schumann, particularly that of gross habit, which not only separate closely related genera but even exclude generically certain species from others which are manifestly their congeners.

Morphology of the Taxonomic Criteria

The danger of basing generic distinctions within the Echitoideae upon habit already has been observed. As a group, the

[16] K. Sch. in Engl. & Prantl, Nat. Pflanzenfam. 4^{2}: 109–189. 1895.
[17] Mgf. Notizblatt 9: 85. 1924.

subfamily is predominantly composed of extensive lianas so characteristic of the tropical American rain-forests. *Forsteronia*, *Prestonia*, *Odontadenia*, and *Echites* (*sensu stricto*) are familiar examples of genera with exclusively volubile habit among all known species. *Neobracea* is fruticose, while *Malouetia* is the only known genus attaining arboreal proportions. The species comprising *Macrosiphonia*, *Salpinctes*, *Galactophora*, and *Rhodocalyx* might with almost equal aplomb be called suffrutescent herbs or subherbaceous undershrubs. *Cycladenia* is unique within the entire family because of its low, subsucculent, herbaceous habit, and its subalpine habitat. Various combinations of habit render that character an extremely fallible guide in particular instances. *Mandevilla* is probably the outstanding example in this regard, including among its many species lianas, suffruticose shrubs, and suffrutescent herbs in a wide range of intergradation.

Although predominantly terete, the stems of certain American Echitoideae display a conspicuous alate development, as in several shrubby species of *Mandevilla* subgen. *Exothostemon* (§ *Eriadenia* Mgf.). Such development of the stem appears to be caused by the activity of the phellogen rather than of the vascular cambium, however, and thus bears only a superficial resemblance to the polydesmic stems of certain other tropical lianas.

Phyllotaxy is relatively uniform throughout the subfamily in America, the distichous arrangement being almost invariable. *Mandevilla Benthamii* (A. DC.) K. Sch. constitutes a striking exception in its ternate or quaternate foliage. The leaves of species of *Laubertia* and *Macrosiphonia* are occasionally ternate as well.

The foliar glands of several genera are easy clues for identification. These organs are small, occasionally quite inconspicuous, multicellular, aculeolate emergences borne upon the ventral surface of the midrib. In *Allomarkgrafia*, *Mesechites*, *Macrosiphonia*, and most species of *Forsteronia*, they occur at the base of the midrib in shapes, positions, and numbers generally characteristic of genera or subgenera and to a somewhat less extent of species. In *Allomarkgrafia*, *Macrosiphonia*, and *Forsteronia* the glands are fusiform and indistinctly gathered into groups of few to several. In *Mesechites*, however, the two component sub-

genera are rather nicely distinguishable by means of the glands, those of subgen. *Eumesechites* assuming a rather flat or laminate shape and occurring in groups of two to five clustered concentrically along the base of the midrib, while those of subgen. *Antillechites* are less conspicuous, fusiform bodies which are predominantly found in pairs radially placed at the very base of the midrib.

In *Mandevilla* subgen. *Eumandevilla*, the foliar glands are fusiform and are grouped at the base of the midrib as in *Allomarkgrafia*, but in subgen. *Exothostemon* the same structures occur in variable numbers along the entire length of the rib. Were it not for three common species supplying an indubitable link between the two subgenera, which also have technical differences in the reproductive organs, the characteristic position of the foliar glands of subgen. *Exothostemon* would render it one of the most easily recognized genera of the subfamily. Species of the latter subgenus, however, have long been popularly associated with those of *Eumandevilla*, and in view of this consideration, together with that of the intermediate characteristics of *M. funiformis* (Vell.) K. Sch., *M. callista* Woodson, and *M. congesta* (HBK.) Woodson, it has been thought desirable to maintain their unity for the present.

The Apocynaceae are popularly known as an exstipulate group. However, immediately subtending the petiole of many species of that family, usually forming a definitely interpetiolar girdle when the phyllotaxy is opposite or verticillate, are more or less conspicuous appendages, variously arranged, which should probably be interpreted as stipular vestiges. In the Echitoideae of the western hemisphere, these structures are usually glandular in function, although in *Odontadenia anomala* (Heurck & Muell.-Arg.) Macbr. they are somewhat foliaceous, this departure from the predominant condition prompting Miers to establish for its inclusion the genus *Perictenia*. A third condition of the interpetiolar appendages has been interpreted as aiding the plant in clinging to a support in the case of certain lianas, as *M. Luetzelburgii* (Ross & Mgf.) Woodson, where the structures develop a phellogen and form relatively stout, frequently more or less reflexed hooks or "kletterhaken." Among certain more advanced genera of Echitoideae the stipular appendages occupy an

intrapetiolar position, as in *Thenardia*, *Fernaldia*, and *Prestonia*. These nodal appendages are frequently diagnostic for species or groups of species, particularly in the case of the genus *Mandevilla*, and have the double merit of being quickly perceived and rather convincing accompanying indicators of natural relationship.

Inflorescence structure in the subfamily is varied, but almost universally resolves into modifications of the raceme and the dichasial cyme. The most frequent modification of the raceme is the spike, and occurs among widely separated species of different genera. The cyme, although found in almost perfect form in certain species of *Echites* (*sensu stricto*) and *Cycladenia*, becomes thyrsiform in *Odontadenia* and others, paniculate in *Forsteronia*, and is transformed into umbellate construction in *Thenardia*. The uniflorous condition is gradually approached from both determinate and indeterminate positions, the former being attained in *Rhabdadenia*, *Echites crassipes* A. Rich., and the Antillean species of *Mesechites*, and the latter in *Salpinctes* and the North American species of *Macrosiphonia*.

A highly specialized type of indeterminate inflorescence which appears to furnish a clue to the relationship of determinate and indeterminate structure in the subfamily is the so-called "bostrychoid raceme," in which the pedicels are clustered in pairs, and not alternate as in the true raceme. Genera possessing this form of inflorescence are *Prestonia*, *Urechites*, *Asketanthera*, and *Angadenia*. In *Allomarkgrafia*, *Mesechites*, *Temnadenia*, and certain species of *Prestonia*, a peculiar structure of inflorescence is found in the di- or trichotomy of the primary peduncle. It is supposed that this type may be due either to true dichotomy of the growth initials, or rather to the suppression of the determinate flower in a primitive, dichasial cyme such as that found in several closely related genera.

By far the most important criteria in the delimitation of the genera and species of Echitoideae are found in the floral organs. Although their presence has been known since the time of publication of *Echites* in 1756, and their importance suspected by Robert Brown, the internal, calycine appendages, known as "squamellae," have not received the consideration which is due them as indicators of natural relationship. The squamellae are present in all

genera of the subfamily as represented in America with the exception of *Elytropus*, *Rhabdadenia*, *Cycladenia*, and *Laubertia*. Where present, they have been found to assume a position either alternate with the calyx-lobes, or opposite them, thus coinciding in general with the position of the nodal, or stipular, appendages. When opposite, the squamellae are solitary, although the individuals may be deeply laciniate. When alternate, they have been found to number from one to many, in which case they may be so numerous as to extend in a more or less uniform ring about the base of the corolla-tube, losing the appearance of an alternate arrangement. The close relationship of the strictly alternate and the indefinite positions, however, is attested by their occurrence in adjacent congeners.

When taken in combination with the foliar glands, the construction of the anther furnishes one of the most reliable clues to relationship among the genera. In all genera having glandular foliage, the enlarged peltate connective, which should be remembered as the chief characteristic of both Echitoideae and Apocynoideae, is very bluntly cordate, or truncate, with various modifications. In the genera with eglandular foliage, with the exception of *Fernaldia* and *Asketanthera*, the basal lobes or auricles are more narrow, and usually sharply acute to subsetaceous. Although the lobing of the connective is similar to that of the former group in *Asketanthera* and *Fernaldia*, the structure of the microsporangia indicates an unmistakable affinity for the latter, being produced into a conspicuous, inwardly protuberant, sterile base. The microsporangia of the former group, on the other hand, are completely and uniformly fertile throughout. Although the major groups of genera enumerated in the appended key are generally divisible upon the structure of the pollen-sac, several modifications occur which render the character difficult to use for practical purposes of identification. Such intergradations are found in genera which fall rather naturally to an intermediate position in the whole group through the use of other key characters.

The importance of the microsporangial structure is reflected in that of the stigma, occasionally referred to in the English literature and in certain studies of this series as the "clavuncle." In those

genera having anthers with truncate or bluntly auriculate connective and uniformly fertile sporangia, as in *Mandevilla*, the stigma is pentagonal-umbraculiform or pentagonal-subglochidiate in shape, except in *Allomarkgrafia* where it is more nearly pentagonal-fusiform. The five ridges of these umbraculiform or subglochidiate structures lie in such a plane that they are appressed to the anther connective immediately below the sporangia and above the insertion of the filament. The papillate surfaces of the stigma lie just at the base of the terminal apices, or "apiculae," and in actual contact with the pollen-sacs.

On the other hand, those genera having anthers with microsporangia produced into an inwardly protuberant, sterile base possess stigmata which are fusiform to subcapitate in shape, as in *Prestonia*. These stigmata usually have a somewhat swollen, sterile tip upon which the sterile base of the pollen-sacs rests. The base of the stigma is frequently elaborated into a membranaceous girdle which is agglutinated to the anther connective just above the insertion of the filament, or such a process may be imitated by an elaboration of the anther connective itself at the place of insertion of the anther. In such stigmata, the papillate or receptive surfaces are median, occupying a space supposedly sheltered from the natural pollen-shed of the same flower. The anthers are so closely cemented into a conical mass about the stigma by means of glandular secretions and the various parts so precisely comprise the whole that the agency of insects in pollination at once suggests itself. At any rate, the structure and relationship of the anthers and stigma, so suggestive of the gynostegium of Asclepiadaceae, when combined with the vegetative characters which have already been stressed, evidently provide a promising clue to generic relationships within the whole subfamily. Diagrams to depict the construction and relation of androecium and gynoecium as described in the paragraphs immediately preceding are provided in text-figure 1.

Surrounding the ovary of all American Echitoideae with the exception of two species of *Mandevilla* § *Montanae* is a cycle of glandular organs roughly simulating the carpels which have been referred to in the English literature and in preceding studies of this series as "nectaries." The same structures have been

called "disc lobes" by Schumann and Markgraf. The nectaries are various in number and constitution. In all species with the exception of those included within the genera *Salpinctes*, *Fernaldia*, and certain others included within *Mandevilla* §§ *Montanae* and *Laxae*, they are five in number, which seems to be basic for the group. In some species these organs may be distinct and

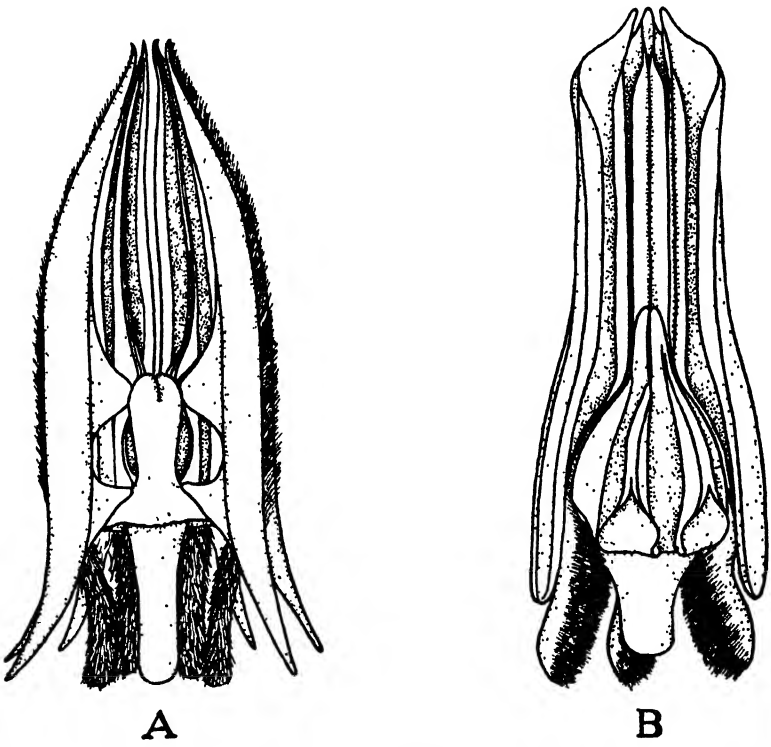


Fig. 1. The relation of stamens and stigma in the Echitoideae. A—*Prestonia trifida* (Poepp.) Woodson, four stamens and stigma; B—*Mandevilla Bridgesii* (Muell.-Arg.) Woodson, three stamens and stigma. Explanation in the text.

separate; in others they may be concrescent and assume a more or less annular condition. The nectaries may vary within a single genus from bodies equalling or somewhat surpassing the carpels to extremely inconspicuous protrusions of the receptacle. The number and condition of the nectaries have been considered of prime importance in previous work undertaking the delimita-

tion of genera within the Echitoideae. Greatly increased material for study has shown the characters of the nectaries to be not so trustworthy as had previously been supposed, however, and in the present revision they are interpreted as specific indicators except in a few peculiar exceptions.

The corolla structure of the subfamily as represented in America presents criteria of specific value in such matters as size, color, and general shape, which may be salverform or infundibuliform, occasionally becoming nearly rotate, as in *Thenardia* and *Forsteronia*. The limb is always five-parted and dextrorsely contorted in aestivation, although a puzzling exception is found in the occasionally sinistrorse convolution of individual flowers of *Forsteronia floribunda* Sw.

Generic criteria of the corolla are found in the thickened, callous faucal annulus of such genera as *Prestonia*, *Rhodocalyx*, and *Laubertia*, and in the internal, faucal appendages attached to the corolla-tube immediately above and behind the insertion of the staminal filaments of many species of *Prestonia*. These appendages are interpreted merely as enations of the corolla.

The follicles display a few specific criteria such as size, position (whether falcate, divaricate, or tortuous), constrictions between the seeds, and presence or lack of an indument. The seeds are in several instances diagnostic of genera. The apical seminal coma, absent only in *Malouetia*, is important, being sessile in the majority of genera, but borne upon a more or less elongate rostrum in *Stipecoma*, *Peltastes*, *Angadenia*, *Rhabdadenia*, and *Urechites*. A unique feature of the fruit and seeds is found in the last-named genus, where the placentae are chaffy, producing numerous deciduous, scaphiform scales which are dispersed with the seeds, which they roughly simulate, in large numbers upon dehiscence of the follicle. This character is perhaps the most striking of any similar features in the entire family.

Geographical Distribution

The geographical distribution of the genera which are included within this study may be rather succinctly expressed since, with the exception of one only, all are confined to the western hemisphere. For the barest purposes of convenience, the genera

which are strictly American may be divided into three main groups composed of those represented upon both the continental mass proper and the islands of the Antilles, those limited to the continent, and those confined to the Antilles. These groups may be amplified and in turn subdivided as follows:

Genera common to both the continent and the Antilles.—Within this group, which comprehends all the larger genera and about two-thirds the total species of the American representation of the subfamily Echitoideae, two subdivisions may be recognized, namely, genera containing at least one species common to both the continent and the Antilles, and those containing one or more endemic Antillean congeners. The first subdivision accentuates the familiar affinity of the flora of the Greater Antilles for that of southern peninsular Florida, the Bahama Islands, certain districts of Central America, and localities of the northern Atlantic coast of South America.

The genus *Echites* (*sensu stricto*) is perhaps the most familiar echitoid liana of the region roughly cited above through its representation by *E. umbellata* Jacq., a frequent inhabitant of swamps and coastal thickets of southern peninsular Florida and its adjacent keys, the Bahama Islands, Cuba, Hispaniola, Jamaica, and the coastal flats of northern Yucatan and British Honduras. *E. crassipes* A. Rich., perhaps better treated as merely a variety of the preceding, is confined to Cuba. Three species of *Echites* also occur locally in Guatemala, Yucatan, Costa Rica, and the Mexican state of Chiapas. It may be mentioned incidentally that the Antillean-continental and the strictly continental species of this genus are separable as sectional units upon morphological grounds.

The range of the genus *Rhabdadenia* is somewhat similar in its Antillean relations to that of *Echites*, since *Rh. biflora* (Jacq.) Muell.-Arg. occurs throughout practically the same territory as does *E. umbellata* Jacq., with the addition of Porto Rico, the French West Indies, and local districts of Atlantic coastal Colombia and British Honduras. The species has also been reported from the coastal swamps of Venezuela, the Guianas, and northern Brazil. Two other species of *Rhabdadenia* occur upon the eastern slope of South America from Colombia to Paraguay.

Vying with the wide distribution of the Antillean species of the two genera immediately preceding, *Urechites lutea* (L.) Britton constitutes a familiar component of coastal thickets in southern peninsular Florida, the Bahama Islands, Cuba, Hispaniola, Jamaica, Porto Rico, the Virgin Islands, and the islands of the Lesser Antilles belonging to France and Great Britain (with the exception of Trinidad). The species has been reported also from British Honduras. Another species of *Urechites* is confined to northern Central America.

The combination of continental and Antillean distribution is exemplified somewhat less vividly by the genera *Forsteronia* (with *F. spicata* (Jacq.) G. F. W. Meyer common to Cuba and localities in northern Central America and Atlantic coastal Colombia, and numerous species confined to Central and South America), and *Mandevilla* (with *M. torosa* (Jacq.) Woodson common to Jamaica and northern Yucatan, and many species confined to the continental mass south of the Tropic of Cancer). The situation of *Angadenia*, with one species, *A. Sagraei* (A. DC.) Miers, common to southern peninsular Florida, the Bahama Islands, and Cuba, and an endemic Cuban species, might more appropriately be noted among the strictly Antillean genera, since the Apocynaceae of peninsular Florida are wholly Antillean in their affinities.

The second subdivision, composed of genera possessing endemic Antillean species, is exemplified by *Prestonia*, *Secondatia*, and *Odontadenia*, the first with two, and the remainder with a single Antillean species of rather limited distribution in addition to numerous strictly continental congeners. *Forsteronia* deserves comment in this group, as it includes two endemic Antillean species, *F. corymbosa* (Jacq.) G. F. W. Mey. and *F. floribunda* Sw., in addition to the Antillean-continental *F. spicata* (Jacq.) G. F. W. Mey. The genus *Mesechites* is particularly noteworthy in this instance, since it is composed of two subgenera limited to the Antillean islands of Cuba and Hispaniola and to the mainland south of Mexico; containing four and six well-defined species respectively.

Genera limited to the continent.—The genera of this group are more numerous, but are monotypic in several instances and thus include fewer species than those of the first category. A relatively

limited distribution is typical of these genera, with three exceptions which will be noted separately. For the sake of convenience, the genera of limited distribution may be epitomized as follows:

1. Endemic genus of the Pacific coastal region of the United States: *Cycladenia*, with one species of California and southern Utah.

2. Endemic genera of southern Mexico and Central America: *Thenardia* and *Fernaldia*.

3. Endemic genera of the upper Amazon valley: *Allomarkgrafia* and *Macropharynx*, the latter monotypic.

4. Endemic genera of northern Brazil and adjacent Venezuela and British Guiana: *Salpinctes* and *Galactophora*.

5. Endemic genera of southeastern Brazil: *Stipecoma*, *Temnadenia*, and *Rhodocalyx*, the first and last monotypic.

6. Endemic genus of Chile: the monotypic *Elytropus*, which is the sole representative of the subfamily in that country.

Beside the twelve genera enumerated immediately above, three others occur with somewhat more complicated distribution: *Laubertia*, with one species in southern Mexico, one in northern Colombia, and one in northeastern Peru; *Peltastes*, with two species in southeastern Brazil, and one species each in northern Paraguay, eastern Bolivia, and northern Colombia; and *Macrosiphonia*, with five species of southeastern Brazil and adjacent Paraguay, Uruguay, and Argentina, and five species of the southwestern United States and adjacent Mexico.

Genera limited to the Antilles.—Only two genera comprise this group, namely, *Neobracea*, with one endemic species of the Bahama Islands, and three of Cuba, and *Asketanthera*, with two endemic species each of Cuba and Hispaniola respectively.

The American genera of Echitoideae predominantly inhabit the tropical and subtropical rain-forests at altitudes of from near sea-level to about 1500 m. elevation, frequently spreading into well-watered thickets as well. Species of such habitats are usually lianas or straggling shrubs bearing large, membranaceous, relatively distant leaves. The unique growth conditions of the plains or "campos" of southeastern South America, on the other hand, evidently stimulate the growth of erect, suffruticose or suffrutescent species characterized by more crowded, smaller,

frequently coriaceous or subcoriaceous foliage. Similar habital modifications are found among species of the plains and plateaus of northern Brazil and adjacent Venezuela and British Guiana. Among such species a striking tendency toward the reduction of the inflorescence manifests itself.

Other characteristic habitats frequented by certain genera and species of the subfamily in the western hemisphere are brackish swamps and coastal thickets. The subalpine distribution is represented by a single genus of small, semi-succulent, perennial herbs frequenting altitudes of approximately 1500–3500 m. in the Pacific southwestern United States. A rough outline of the chief types of habitat and their predominant Echitoideae may be provided as follows:

Rain-forests and thickets (frequently riparian): *Allomarkgrafia, Asketanthera, Fernaldia, Forsteronia, Laubertia, Macropharynx, Malouetia, Mandevilla, Mesechites, Odontadenia, Peltastes, Prestonia, Secondatia, Stipecoma, Temnadenia, Thenardia, Trachelospermum.*

Coastal swamps: *Echites, Malouetia* spp., *Mesechites* spp., *Rhabdadenia, Trachelospermum.*

Coastal thickets (not swampy, typically arenaceous): *Angadenia, Echites* spp., *Neobracea, Rhabdadenia* spp., *Urechites.*

Plains and plateaus: *Elytropus, Galactophora, Macrosiphonia, Mandevilla* spp., *Rhabdadenia* spp., *Rhodocalyx, Salpinctes.*

Subalpine: *Cycladenia.*

RELATIONSHIP OF OLD AND NEW WORLD GENERA

The problem of the relationship of the American genera of Echitoideae to those of the Old World is a relatively simple one, as has already been implied, since of the total only one is indigenous to both hemispheres. The generic affinity of *Echites difformis* Walt. has been a moot question almost since its publication, having been included more or less intermittently within the genera *Echites, Forsteronia,* and *Secondatia* by successive authors. In 1878 the species attracted the attention of Dr. Asa Gray, probably as a result of his classical studies of the affinity of the flora of the southeastern United States for that of eastern Asia, who removed it to the Asiatic genus *Trachelospermum.* As a

matter of fact, the distribution of *T. difforme* along the southern Atlantic coastal plain of North America from southern Delaware to Georgia, thence to eastern Texas and up the lowlands of the former Mississippi embayment to southern Missouri, Illinois, and Indiana, appears strongly indicative of eastern Asiatic affinities, and presents a striking parallel with that of *Taxodium distichum*, a species of great antiquity, with which it is often associated.

With the factor of geographical distribution deleted, the reasons for placing *T. difforme* within *Trachelospermum* are rather extenuated, resting almost solely upon the basis of the geminate calycine squamellae and subcapitate stigma. In all species of *Secondatia* known at the present time the squamellae are solitary and alternate with the calyx-lobes, and the stigma is narrowly fusiform. These rather inconsequential characters would appear to be the only evident distinctions of the two genera, and one is confronted with the dilemma whether to merge the two in the interests of natural classification or to maintain them separate upon whatever slight if constant criteria for the sake of convenience and constancy.

The most apparent connecting-link between the Echitoideae of the Old World and the New, then, is provided in the rather obscure relationship of the Asiatic-southeastern North American genus *Trachelospermum*, and the South American-Antillean *Secondatia*. A second example of affinity is afforded by the Asiatic-Oceanic genus *Parsonsia* and the South and Central American-Antillean genus *Forsteronia*, of which the degree of syncarpy or apocarpy would appear to be the chief distinguishing characters. A third line of relationship between the Apocynaceous flora of the two hemispheres, involving the Asiatic-African genera *Kibatalia* and *Funtumia*, and the American genera *Malouetia* and *Forsteronia*, will be treated in a subsequent discussion. With the exception of the genera mentioned, the distinction of the Echitoideae of the two hemispheres is impressive.

Although several species of the Old World Echitoideae are cultivated in America, and in the warmer latitudes tend to escape and naturalize, these are usually so well known that it has been decided to exclude them from the present account, limiting it to those strictly indigenous to the western hemisphere.

KEY TO THE AMERICAN GENERA OF ECHITOIDEAE

A. Anthers with thick obtuse basal auricles, or truncate; stigma pentagonal-umbraculiform or subglochidiate (except in *Allomarkgrafia*); upper surface of leaves glandular upon the midrib (except in certain species of *Mandevilla*).

B. Inflorescence bostrychoid, di- or trichotomously compound.

C. Corolla infundibuliform; stigma fusiform........I. Allomarkgrafia

CC. Corolla salverform; stigma umbraculiform...........II. Mesechites

BB. Inflorescence not bostrychoid, simple (or very rarely obscurely paniculate in certain species of *Mandevilla*).

C. Flowers hemeranthous; stigma umbraculiform; lianas, or infrequently suffrutescent herbs.......................III. Mandevilla

CC. Flowers nyctanthous or vespertine; stigma subglochidiate;* suffrutescent herbs...............................IV. Macrosiphonia

AA. Anthers with slender or attenuate basal auricles (except in *Asketanthera*, *Fernaldia* and *Echites elegantula*); stigma fusiform to subcapitate; leaves eglandular (except in certain species of *Forsteronia*).

B. Squamellae predominantly more numerous than the calyx-lobes, and alternate with them, indefinitely and uniformly distributed, or obsolete; corolla not provided with a callous faucal annulus.

C. Squamellae present.

D. Seminal coma sessile or absent.

E. Nectaries 5, separate or more or less concrescent.

F. Corolla salverform, relatively small.

G. Inflorescence thyrsiform; seeds apically comose; lianas.

H. Anthers exserted, at least the tips; leaves glandular in most species.................. ... ...V. Forsteronia

HH. Anthers wholly included; leaves not glandular.

I. Squamellae solitary; stigma narrowly fusiform. VI. Secondatia

II. Squamellae geminate; stigma subcapitate............ ....VII. Trachelospermum

GG. Inflorescence umbellate; seeds without an apical coma; shrubs or small trees....................VIII. Malouetia

FF. Corolla infundibuliform, or large and showy if salverform.

G. Calyx-lobes closely imbricated at anthesis; lianas........ ....IX. Odontadenia

GG. Calyx-lobes not imbricated at anthesis, or scarcely so; shrubs and suffrutescent herbs.

H. Flowers relatively small; squamellae in groups alternate with the calyx-lobes; anthers pubescent dorsally; shrubs..............................X. Neobracea

HH. Flowers large and showy; squamellae indefinitely distributed; anthers glabrous; suffrutescent herbs.... ....XI. Galactophora

EE. Nectaries 2, separate..........................XII. Salpinctes

DD. Seminal coma rostrate.

E. Leaves peltate.

*Character suggested by Dr. Fr. Markgraf, Berlin-Dahlem.

F. Corolla infundibuliform; calyx-lobes foliaceous; squamellae indefinitely distributed........................XIII. PELTASTES

FF. Corolla salverform; calyx-lobes scarious; squamellae in groups alternate with the calyx-lobes..........XIV. STIPECOMA

EE. Leaves not peltate.

F. Anthers without linear apical appendages; placentae not chaffy..XV. ANGADENIA

FF. Anthers with linear apical appendages; placentae chaffy in fruit..XVI. URECHITES

CC. Squamellae obsolete.

D. Shrubs and lianas; nectaries separate or essentially so.

E. Flowers large and showy; seminal coma rostrate. XVII. RHABDADENIA

EE. Flowers relatively small; seminal coma sessile.....XVIII. ELYTROPUS

DD. Semi-succulent perennial herbs; nectaries concrescent..XIX. CYCLADENIA

BB. Squamellae as numerous as the calyx-lobes, and opposite them, occasionally deeply lacerate, or if obsolete the corolla provided with a callous faucal annulus.

C. Orifice of the corolla not annulate; anthers wholly included (except in *Thenardia*).

D. Corolla infundibuliform or salverform; anthers wholly included.

E. Inflorescence determinate.........................XX. ECHITES

EE. Inflorescence indeterminate.

F. Inflorescence di- or trichotomously compound..XXI. TEMNADENIA

FF. Inflorescence simple.

G. Calyx 5-parted; pedicels subtended by solitary bracts.

H. Calyx-lobes and bracts scarious; corolla infundibuliform, villous within, at least the lobes.........XXII. FERNALDIA

HH. Calyx-lobes and bracts foliaceous; corolla salverform, glabrous within..................XXIII. ASKETANTHERA

GG. Calyx 7–9-parted, immediately subtended by many bracts...............................XXIV. MACROPHARYNX

DD. Corolla rotate (or rarely subsalverform); anthers exserted...XXV. THENARDIA

CC. Orifice of the corolla annulate; anthers exserted (except in certain species of *Prestonia*).

D. Squamellae present.

E. Lianas; inflorescence lateral, rarely subterminal; petioles subtended by few to several pectinate glands; corolla usually with 5 internal faucal appendages............XXVI. PRESTONIA

EE. Suffrutescent herbs; inflorescence terminal; petioles not glandular; corolla exappendiculate within....XXVII. RHODOCALYX

DD. Squamellae obsolete........................XXVIII. LAUBERTIA

I. ALLOMARKGRAFIA Woodson

Allomarkgrafia Woodson, Ann. Mo. Bot. Gard. 19: 45. 1932.

Lactescent, suffruticose lianas. Stems volubile, terete; branches opposite below, becoming alternate above. Leaves

opposite, the ventral surface bearing several inconspicuous, glandular emergences indefinitely clustered at the base of the midrib; petioles somewhat girdling at the node into a slightly dilated, minutely appendiculate, stipular ring. Inflorescence lateral, alternate, bostrychoidally racemose, the peduncle regularly and divaricately di- or trichotomously divided, the pedicels opposite, subtended by solitary bracts. Calyx 5-parted, the lobes subequal, imbricated, cleft nearly to the receptacle, bearing within many uniformly distributed, glandular squamellae. Corolla infundibuliform, the tube straight, narrowly cylindrical below, abruptly dilated into the broad, campanulate throat at the insertion of the stamens, the limb 5-parted, actinomorphic, dextrorsely convolute. Stamens 5, inserted at the base of the corolla-throat, wholly included; anthers connivent and agglutinated to the stigma, consisting of 2 parallel, uniformly fertile sporangia borne ventrally near the apex of an enlarged, sagittate, obtusely 2-auriculate, peltate connective; pollen granular; filament short, subcylindrical, retrorsely pilose. Carpels 2, united at the apex by an elongate stylar shaft surmounted by the fusiform stigma; ovules many, several-seriate, borne upon an axile, binate placenta. Nectaries 5, separate or somewhat concrescent at the base. Follicles 2, apocarpous, terete, acuminate, dehiscing along the ventral suture, containing many dry, subscaphiform, truncate, apically comose seeds.

Type species: *Allomarkgrafia ovalis* (Mgf.) Woodson, Ann. Mo. Bot. Gard. **19**: 45. 1932.

KEY TO THE SPECIES

a. Inflorescence relatively sparse and lax; corolla 4–6 cm. long; squamellae narrowly ligular; nectaries shorter than the ovary; plants of northeastern Peru .... *1. A. ovalis*

aa. Inflorescence relatively dense and congested; corolla 3–3.5 cm. long; squamellae subquadrate; nectaries longer than the ovary; plants of northeastern Colombia .... *2. A. plumeriaeflora*

1. **Allomarkgrafia ovalis** (Mgf.) Woodson, Ann. Mo. Bot. Gard. **19**: 45. 1932.

Echites ovalis Mgf. Notizblatt **9**: 79. 1924.

Echites ovalis Tafalla, ex Mgf. loc. cit. 1924, nom. nud. in synon.

Plate 1.

Glabrous, suffruticose lianas; stems relatively stout, terete; leaves narrowly oblong-elliptic, apex abruptly acute-subcaudate, base obtuse or rounded, 10–15 cm. long, 3.5–5.0 cm. broad, coriaceous, glabrous; petiole 1.0–1.25 cm. long; inflorescence somewhat shorter than the subtending leaves, bearing 15–20 greenish- or yellowish-white flowers; pedicels 2.0–2.5 cm. long, the subtending bracts minute, scarious; calyx-lobes ovate-oblong, obtuse or broadly acute, 0.3–0.4 cm. long, scarious, glabrous, bearing within numerous, narrowly ligular squamellae; corolla infundibuliform, glabrous without, the proper-tube 1.5–2.0 cm. long, about 0.3 cm. in diameter at the base, the throat campanulate, 1.5–2.5 cm. long, about 1 cm. in diameter at the orifice, the lobes obliquely obovate-reniform, 1.0–1.5 cm. long, widely spreading; anthers narrowly oblong-sagittate, 0.5–0.6 cm. long, glabrous; ovary oblong-ovoid, 0.3–0.4 cm. long, glabrous; stigma 0.3–0.5 cm. long; nectaries oblong-ovoid, about 0.2 cm. long; mature follicles unknown.

PERU: LORETO: Berge südl. Moyobamba in straucharmen Wald, alt. 900–1000 m., Sept. 4, 1904, *Weberbauer 4686* (B, MBG, photograph and analytical drawings); Laguna, alt. 600 m., date lacking, *Werckle 69* (B); Chicoplaya, 1799, *Tafalla s. n.* (B, TYPE); Manfinfa, on the upper Rio Nanay, June–July, 1929, *Williams 1133* (FM).

2. **Allomarkgrafia plumeriaeflora** Woodson, spec. nov., suffruticosa volubilis ut dicitur ca. 25–35 m. altitudine pertinens; ramulis teretibus vel leviter subcompressis glabris cortice virido-brunneis maturitate dense lenticellatis; foliis oppositis petiolatis oblongo-ellipticis breviter acuminatis basi obtusis rotundatisve 14–16 cm. longis 5.0–5.5 cm. latis coriaceis nervo medio supra indistincte multiglanduligero caeterumque glabris; petiolis 1.5–1.7 cm. longis; inflorescentiis terminalibus plurifloris congestis; pedunculo petiolos subaequante; pedicellis 0.7–0.8 cm. longis post maturitatem paullulo accrescentibus; calycis laciniis late ovatis obtusis 0.3–0.4 cm. longis scariaceis glabris intus basi 2-glanduligeris; corollae infundibuliformis dilute gilvae extus glabrae tubo proprio 1.0–1.2 cm. longo basi ca. 0.25 cm. diametro metiente paulo supra basem aliquid dilatato deinde apicem versus gradatim attenuato ibique staminigero faucibus late conico-

campanulatis 0.7 cm. longis ca. 0.7 cm. diametro metientibus lobis late dolabriformibus obtusis 1.5 cm. longis patulis; antheris oblongo-oblanceolatis obtuse auriculatis 0.5 cm. longis glabris; ovario oblongoideo ca. 0.3 cm. longo glabro; stigmate fusiformi basi maniculato 0.275–0.3 cm. longo; nectariis anguste oblong-oideo-fusiformibus 0.4 cm. longis; folliculis desiderantibus.

Glabrous, suffruticose lianas said to attain a height of 25–35 m.; stems terete or slightly compressed, glabrous, abundantly lenticellate when fully mature; leaves oblong-elliptic, apex shortly acuminate, base obtuse or rounded, 14–16 cm. long, 5.0–5.5 cm. broad, coriaceous, glabrous; petiole 1.5–1.7 cm. long; inflorescence much shorter than the subtending leaves, the peduncle about as long as the subtending petioles, bearing numerous, showy, cream-colored flowers; pedicels 0.7–0.8 cm. long, the subtending bracts ovate, acuminate, 0.2–0.3 cm. long, scarious, persistent; calyx-lobes broadly ovate, obtuse, 0.3–0.4 cm. long, scarious, glabrous, bearing within 2 subquadrate squamellae; corolla infundibuliform, glabrous without, the proper-tube 1.0–1.2 cm. long, about 0.25 cm. in diameter at the base, somewhat dilated toward the middle, thence gradually attenuate to the insertion of the stamens, the throat broadly conical-campanulate, 0.7 cm. long, about 0.7 cm. in diameter at the orifice, the lobes broadly dolabriform, obtuse, 1.5 cm. long, spreading; anthers oblong-oblanceolate, 0.5 cm. long, glabrous; ovary oblongoid, about 0.3 cm. long, glabrous; stigma 0.275–0.3 cm. long; nectaries narrowly oblongoid-fusiform, 0.4 cm. long; follicles unknown.

COLOMBIA: BOYACA: forest's edge at stream side, El Umbo, alt. 3200 ft., Oct. 13, 1932, *Lawrance 534* (MBG, TYPE).

Arriving as this paper goes to press, *A. plumeriaeflora* must be included not only as an additional species of a previously monotypic genus, but because it is a novelty from a poorly understood region of great botanical interest. The relationships of this species to *A. ovalis* of northeastern Peru are outlined in the key. Mr. Lawrance has also collected from the region of El Umbo a new species of *Mandevilla*, intermediate between the subgen. *Eumandevilla* and *Exothostemon,* which is described in a subsequent paragraph.

II. Mesechites Muell.-Arg.

Mesechites Muell.-Arg. in Mart. Fl. Bras. 6[1]: 150. 1860; Miers, Apoc. So. Am. 229. 1878, in part, as to subgen. *Didymadenia.*

Echites of many authors, in part, not P. Br.

Lactescent, suffruticose or suffrutescent lianas. Stems volubile, terete; branches opposite below, becoming alternate above. Leaves opposite, the ventral surface bearing 1–4 inconspicuous, glandular emergences clustered at the base of the midrib; petioles somewhat girdling at the node into a slightly dilated, minutely appendiculate or occasionally exappendiculate, stipular ring. Inflorescence lateral, alternate, bostrychoïdally racemose, the peduncle rather irregularly di- or trichotomously divided, the pedicels indefinitely congested, subtended by solitary bracts. Calyx 5-parted, the lobes subequal, imbricated, cleft nearly to the receptacle, bearing within several alternate or indefinitely distributed squamellae. Corolla salverform, the tube straight, slightly dilated at the insertion of the stamens, the limb 5-parted, actinomorphic, dextrorsely convolute. Stamens 5, inserted about midway or somewhat above within the corolla-tube, wholly included; anthers connivent and agglutinated to the stigma, consisting of 2 parallel, uniformly fertile sporangia borne ventrally near the apex of an enlarged, sagittate, obtusely 2-auriculate, peltate connective; pollen granular; filament short, subcylindrical, minutely pilose. Carpels 2, united at the apex by an elongate, stylar shaft surmounted by the umbraculiform stigma; ovules many, several-seriate, borne upon an axile, binate placenta. Nectaries 5, separate or somewhat concrescent at the base. Follicles 2, apocarpous, terete, dehiscing along the ventral suture, containing many dry, subscaphiform, truncate, apically comose seeds.

Type species: *Mesechites Mansoana* (A. DC.) Woodson, Ann. Mo. Bot. Gard. **20:** 636. 1933.

KEY TO THE SUBGENERA

a. Corolla greenish-white flushed with red or purple, occasionally yellowish; foliar glands 1–4, laminate or irregularly pectinate, clustered concentrically; species of Central and South America (including Trinidad and Tobago) ....Subgen. I. Eumesechites

aa. Corolla cream-colored or pink; foliar glands 2, fusiform, clustered radially; species of Cuba and Hispaniola..................Subgen. II. Didymadenia

Subgen. I. Eumesechites Woodson, n. subgen.

Corolla greenish-white flushed with red or purple, or yellowish; foliar glands 1–4, laminate or irregularly pectinate, clustered concentrically; suffruticose lianas of Central and South America, including Trinidad and Tobago. *Spp. 1–6.*

KEY TO THE SPECIES

a. Leaves firmly membranaceous or chartaceous.
  b. Corolla-lobes about half as long as the tube; species of Central and northern South America.
    c. Plants glabrous; corolla-tube 1.5–2.5 cm. long .... *1. M. trifida*
    cc. Plants densely puberulent to glabrate; corolla-tube about 1.0–1.25 cm. long .... *2. M. bicorniculata*
  bb. Corolla-lobes ¼–⅛ as long as the tube; plants of Paraguay .... *3. M. Sanctae-Crucis*
aa. Leaves coriaceous.
  b. Calyx-lobes broadly acute to rounded; species of Peru, Bolivia, and south-central Brazil.
    c. Plants minutely and irregularly puberulent; leaves broadly and rather obscurely cordate; plants of Peru and Bolivia.... *4. M. acuminata*
    cc. Plants glabrous; leaves not cordate; plants of south-central Brazil and adjacent Bolivia .... *5. M. Mansoana*
  bb. Calyx-lobes long-acuminate or subsetose; plants of Colombia... *6. M. citrifolia*

1. **Mesechites trifida** (Jacq.) Muell.-Arg. in Mart. Fl. Bras. 6^1: 151. 1860.

Echites trifida Jacq. Enum. Syst. Pl. Carib. 13. 1760; Select. Stirp. Am. Hist. **1**: 31; **2**: *pl. 24.* 1763; L. Sp. Pl. ed. 2. 307. 1762; A. DC. in DC. Prodr. **8**: 454. 1844; Miers, Apoc. So. Am. 202. 1878.

Echites japurensis Stadelm. Flora **24**[1]: Beibl. 19. 1841; A. DC. loc. cit. 454. 1844; Miers, loc. cit. 205. 1878.

Echites tubulosa Benth. in Hook. Jour. Bot. **3**: 249. 1841; A. DC. loc. cit. 1844; Miers, loc. cit. 202. 1878.

Echites surinamensis Miq. Stirp. Surinam. 155. 1850; Miers, loc. cit. 203. 1878.

Echites disadena Miq. loc. cit. 156. 1850; Miers, loc. cit. 204. 1878.

Echites cuspidata Willd. ex Muell.-Arg. loc. cit. 152. 1860, nom. nud. in synon.

Mesechites japurensis (Stadelm.) Muell.-Arg. loc. cit. 152. 1860.

Mesechites surinamensis (Miq.) Muell.-Arg. Linnaea **30:** 454. 1860.

Mesechites disadena (Miq.) Muell.-Arg. loc. cit. 1860.

Echites pallida Miers, loc. cit. 195. 1878.

Echites trifida Griseb. ex Miers, loc. cit. 202. 1878, sphalm in synon.

Echites rigida Rusby, Mem. N. Y. Bot. Gard. **7:** 325. 1927.

Glabrous or essentially glabrous, suffruticose lianas; stems relatively stout; leaves ovate to ovate-oblong, occasionally oblong-lanceolate, apex rather abruptly acuminate to obtuse, mucronulate, base obtuse or rounded, usually more or less cordate, 5–12 cm. long, 2–8 cm. broad, firmly membranaceous, glabrous; petiole 0.5–3.0 cm. long; nodal appendages mostly geminate, rarely obsolete; inflorescence about half as long as the subtending leaves, conspicuously compound, the floriferous branches about as long as the sterile, primary peduncle, bearing 10–25 greenish-white, red- or purple-flushed flowers; pedicels 0.5–1.0 cm. long, the subtending bracts minutely ovate, scarious; calyx-lobes broadly oblong, obtuse or rounded, 0.3–0.5 cm. long, glabrous without or the margins minutely ciliolate; corolla salverform, the tube 1.5–2.5 cm. long, about 0.15 cm. in diameter at the base, somewhat enlarged at the insertion of the stamens, the lobes obliquely obovate-oblong, 0.75–1.5 cm. long, sharply reflexed; anthers 0.4–0.6 cm. long; ovary oblong-ovoid, about 0.2 cm. long, glabrous; stigma 0.2–0.25 cm. long; nectaries compressed-ovoid, about half as long as the ovary; follicles 15–40 cm. long, continuous or essentially so; seeds about 0.75 cm. long, the tawny coma 1.5–2.0 cm. long.

British Honduras: Stann Creek, Dec. 9, 1931, *Schipp S47* (MBG).

Honduras: atlantida: wet thicket, vicinity of Tela, at sea-level, Dec. 14, 1927–March 15, 1928, *Standley 53619* (FM).

Guatemala: alta verapaz: Cubilquitz, alt. 350 m., Febr., 1904, *Tuerckheim 8540* (G, US); Finca Mocca, alt. 1400 ft., Dec. 4, 1919, *Johnson 88* (NY); santa rosa: Jumaytepeque, alt. 6000 pp., Aug., 1892, *Heyde & Lux 3994* (G, K, US).

Costa Rica: guanacaste: buissons à Nicoya, Jan., 1900, *Tonduz 13686* (B, BM, G, K); puntarenas: forets à Boruca, Sept., 1891, *Pittier 4417* (Bx, US); près du Desmonte, route de Puntarenas, alt. 500 m., Sept. 17, 1888, *Pittier 471* (Bx); cartago: haies à Turrialba, Nov., 1893, *Tonduz 8322* (Bx); data incomplete: *Ørsted 15542* (C).

Panama: cocle: Aguadulce, in savannas near sea-level, Dec. 3–5, 1911, *Pittier 4941* (US); panama: in thickets, between Las Sabanas and Matias Hernandez, Jan.

21, 1924, *Standley 31810* (US); moist thicket, Juan Diaz, Jan. 11, 1924, *Standley 30562* (US); brushy slope, Taboga Island, Dec., 1923, *Standley 27936* (US); moist thicket, vicinity of Juan Franco Race-track, Dec. 21, 1923, *Standley 27717* (US); more or less forested slopes, in sun, Taboga Island, Febr. 26–27, 1923, *Macbride 2777* (FM); Agricultural Experiment Station, Matias Hernandez, Nov. 20, 1914, *Pittier 6869* (US); prope urbem Panama, date lacking, *Seemann 156, 161* (K); COLON: brushy slope between France Field, C. Z., and Catival, Jan. 9, 1924, *Standley 30290* (US); CANAL ZONE: moist woods, Balboa, Nov., 1923–Jan., 1924, *Standley 29251* (US); Rio Agua Salud, near Frijoles, March 6, 1923, *Piper 5850* (US, S); open bank, climbing on shrubs, near Ft. Randolph, May 26, 1923, *Maxon & Harvey 6507* (US); Gatun Sta., Febr. 12, 1860, *Hayes 148* (NY).

COLOMBIA: BOLIVAR: river bank, Los Hurtados, on Rio Sinu, alt. 40–70 m., Febr. 4, 1918, *Pennell 4155* (NY); low thicket, Bodega Central, along Rio Magdalena, alt. 70 m., Sept. 29, 1922, *Pennell 12002* (NY); thicket, Hacienda de Coloncito, near Turbaco, alt. 200–300 m., Nov. 9, 1926, *Killip & Smith 14370* (US); river flat, Boca Tai, on Rio Sinu, alt. 50–80 m., Febr. 8, 1918, *Pennell 4181* (NY); clearing on river bank, Boca Tai, on Rio Sinu, March 7, 1918, *Pennell 4617* (NY); MAGDALENA: Santa Marta, alt. 2000 ft., Dec., 1898, *Smith 1641* (Bx, FM, G, MBG, NY, S, US); vicinity of Santa Marta, alt. 150 ft., Aug., year lacking, *Smith 1642* (B, BM, FM, G, K, MBG); Santa Marta, 1845, *Purdie s. n.* (K); ANTIOQUIA: Armenia, vicinity of Medellin, Sept. 15, 1927, *Toro 650* (NY); thickets below Santa Barbara, alt. 900–1500 m., Sept. 21, 1922, *Pennell 10884* (NY); SANTANDER DEL NORTE: Ocaña, Nov. 19, 1877, *Kalbreyer 261* (B); TOLIMA: Rio Paz, alt. 1000–1300 m., March, year lacking, *Lehmann 5645* (B, K); META: trail in thicket, Villavicencio, alt. 500 m., Aug. 26–31, 1917, *Pennell 1525* (NY).

ECUADOR: GUAYAS: Panigon Plantation, 8 mi. south of Milagro, alt. 50 m., July 11–13, 1923, *Hitchcock 20595* (G, NY, US); Milagro, alt. 50 m., June 30–July 2, 1923, *Hitchcock 20258* (G, US); ad fl. Daule prope Guayaquil, Sept., 1861, *Spruce 6485* (B, BB, K); Rio Chimbo, date lacking, *Rimbach 22* (B).

VENEZUELA: MERIDA: Tovar, 1854–55, *Fendler 1031* (BB, G, K, MBG, NY); entre La Vega y San Juan, Valle de Chama, Jan. 29, 1928, *Pittier 12759* (FM, MBG, MC, NY); CARABOBO: Cumbre, May, year lacking, *Linden 580* (BB); Las Trincheras, Oct. 30, 1917, *Pittier 7638* (MC); same locality, 1891–92, *Warming 252* (C); LARA: Rio Turbio, cerca de Barquisimeto, June 13, 1925, *Saer 239* (MC); TRUJILLO: subida del puente de Motatan a Carvajal cerca de Valera, Nov. 21, 1922, *Pittier 10760* (MC); cerca de Cuchilla, en matorrales, Jan. 9, 1929, *Pittier 13121* (MC); YARACUY: Cayure, Sept. 24, 1923, *Pittier 11212* (MC); PORTUGUESA: exact locality lacking, Dec. 28, 1925, *Pittier 12037* (MC); DISTRITO FEDERAL: alrededores del Valle, cerca de Caracas, Aug. 28, 1921, *Pittier 9730* (MC); Caracas, 1824, *Vargas s. n.* (DC); AMAZONAS: Tamatama, Rio Orinoco, alt. 100 m., Jan. 12–24, 1930, *Holt & Gehriger 269* (MBG, MC, US).

TRINIDAD: hillside, Saline Bay, March 9, 1920, *Britton 460* (NY); exact locality lacking, 1876, *Sieber 373* (DC, DL, MBG); Arena, Government Forest, April 10, 1924, *Broadway s. n.* (FM); exact locality and date lacking, *Purdie s. n.* (K); Maracas, road to bay, Aug. 18, 1927, *Broadway 6733* (B, K).

BRITISH GUIANA: Mazaruni River, Aug., 1880, *Jenman 799* (K); Oreala, savanna, Oct., 1879, *im Thurn s. n.* (K); prope cataractam Kaietur, Aug., 1866, *Appun 1771* (K); data incomplete, *Schomburgk 311* (B, BB, DC, FM, K, US).

DUTCH GUIANA: data incomplete, 1843, *Hostmann 549* (B, BB, BM, K); March, 1842, *Hostmann 469* (DL); *Hostmann 55* (B).

French Guiana: data incomplete, 1820, *Perrottet s. n.* (DL); 1819–21, *Poiteau s. n.* (DL).

Brazil: amazonas: Tonantins, ripis rivi inundatis, Nov. 11, 1927, *Ducke 21613* (B, US); Rio Branco, June, 1909, *Ule 7826* (B, K); Rio Negro, gapo of south shore, May, 1851, *Spruce 1348* (B, BM, Bx, K); insula Ajarauy, Rio Branco, ad ripas, March, 1913, *Kuhlmann 3044* (B, US); Rio Antinamary, ad fl. Rio Acre, silva paludosa, April 1, 1904, *Huber 21769* (B); para: beside the Jari, lower Amazon, Nov. 21, 1873, *Traill 519* (K); Port-Real, in the campo of Corasco, close to the village, Dec. 19, 1828, *Burchell 8510* (K); ad cataractas fl. Aripecuru, Dec., 1849, *Spruce 551* (B); maranhão: exact locality lacking, Nov. 14, 1923, *Snethlage 328* (B).

For a species which is so widespread, *M. trifida* is rather uniform in all features which could be considered as specific. The most variable are the shape and size of the leaves, which may be epitomized as normally broadly ovate-oblong, obscurely cordate, and ranging from 8 to 12 cm. in length. Individual specimens occasionally bear leaves which vary to elliptic-lanceolate, however, and the size may be considerably reduced.

The species occurs upon both Atlantic and Pacific slopes in Central America, frequenting rather moist thickets at relatively low altitudes. Rather common in Panama, it is of relatively infrequent occurrence northward, at present being unrecorded from Nicaragua and Salvador. At its northern limit in British Honduras, it has been found in recently cultivated fields, probably indicating an advancing distribution.

In South America there appears to have been two main directions of dispersal, one invading the Colombian river valleys draining into the Atlantic Ocean, Venezuela, and the Guianas, where it is a frequent liana of moist, low thickets and alluvial flats; and the second, probably an extension of the former, down the Orinoco and Rio Negro valleys to the Amazon. The species here extends down the Amazon River valley as far as Para and Maranhão, choosing much the same habitat as northward, although apparently of less frequent occurrence.

An interesting instance of isolation in the distribution of *M. trifida* is found in its occurrence in the Province of Guayas, Ecuador, which is the only known locality of the genus upon the Pacific coast south of Panama. Here there is a parallel in the distribution of *Stemmadenia obovata* (Hook. & Arn.) K. Sch. var. *mollis* (Benth.) Woodson.

2. **Mesechites bicorniculata** (Rusby) Woodson, Ann. Mo. Bot. Gard. 19: 387. 1932.

Echites bicorniculata Rusby, Descr. So. Am. Pl. 86. 1920.

Minutely and densely puberulent, rarely glabrate, suffruticose lianas; stems relatively stout; leaves broadly oblong-elliptic, apex broadly obtuse, mucronulate, base broadly and rather obscurely cordate, 5–7 cm. long, 2.0–3.5 cm. broad, firmly membranaceous, either surface densely puberulent, the upper somewhat glabrescent at maturity; petiole 0.5–0.75 cm. long; nodal appendages mostly geminate; inflorescence about half as long as the subtending leaves, conspicuously compound, the floriferous branches somewhat shorter than the sterile, primary peduncle, bearing 10–20 greenish-white, red- or purple-flushed flowers; pedicels about 0.4 cm. long, somewhat accrescent at maturity, the subtending bracts minutely ovate, scarious; calyx-lobes broadly ovate-oblong, obtuse or rounded, 0.2–0.3 cm. long; corolla salverform, the tube about 1.0–1.25 cm. long, about 0.15 cm. in diameter at the base, somewhat enlarged at the insertion of the stamens, glabrous without, the lobes obliquely obovate-oblong, 0.5–0.75 cm. long, sharply reflexed; anthers 0.5 cm. long; ovary oblong-ovoid, about 0.2 cm. long, minutely puberulent-papillate; stigma 0.2 cm. long; nectaries compressed-ovoid, about half as long as the ovary; follicles unknown.

Colombia: magdalena: thickets, plains near sea-level, Cienaga, Sept. 10, 1898, *Smith 1640* (FM, K, NY, type, MBG, photograph and analytical drawings); santander [atlantico?]: Badillo, alluvial flat, Rio Magdalena, alt. 80–90 m., Jan. 16, 1918, *Pennell 3911* (MBG, NY).

This species is scarcely distinguishable from the preceding save by the conspicuous indument, and might better be classified as a variety upon examination of a greater representation of both.

3. **Mesechites Sanctae-Crucis** (S. Moore) Woodson, Ann. Mo. Bot. Gard. 19: 387. 1932.

Echites (§ *Mesechites*) *Sanctae-Crucis* S. Moore, Trans. Linn. Soc. Bot. II. 4: 396. 1895.

Echites trifida Jacq. var. *Sanctae-Crucis* (S. Moore) Malme, Bull. Herb. Boiss. II. 4: 196. 1904.

Suffruticose lianas; stems relatively stout, minutely puberulent when young, glabrate or puberulent at the nodes when fully

mature; leaves oblong-elliptic to obovate-oblong, apex obtuse to abruptly acuminate, mucronulate, base broadly and obscurely cordate, 5–12 cm. long, 2.5–7.0 cm. broad, firmly membranaceous, either surface glabrous or essentially so; petiole 0.75–1.25 cm. long; nodal appendages obsolete; inflorescence about half as long as the subtending leaves, conspicuously compound, the floriferous branches somewhat shorter than the sterile, primary peduncle, bearing 15–35 congested, yellowish, reddish-flushed flowers; pedicels 0.75–1.0 cm. long, the subtending bracts minutely ovate, scarious; calyx-lobes ovate-oblong, obtuse to broadly acute, 0.2 cm. long, essentially glabrous; corolla salverform, the tube 1.25–1.5 cm. long, about 0.15 cm. in diameter at the base, somewhat enlarged at the insertion of the stamens, the lobes obliquely obovate-oblong, 0.4–0.5 cm. long, sharply reflexed; anthers 0.4 cm. long; ovary oblongoid, 0.2 cm. long, glabrous; stigma 0.25 cm. long; nectaries oblongoid, about half as long as the ovary; follicles relatively slender, continuous or essentially so, 12–25 cm. long, glabrous; seeds 1.25 cm. long, the brilliantly tawny coma 1.5 cm. long.

PARAGUAY: zwischen Rio Apa und Rio Aquidaban, Dec., 1908, *Fiebrig 4313* (B, BM, K); Pilcomayo River, Jan., 1888–90, *Morong 895* (FM, MBG, NY); near Asuncion, 1888–90, *Morong 380* (MBG, NY); prope Concepcion, Oct., 1901, *Hassler 7621* (BB, BM, K); Rio Paraguay à l'Assomption, Febr.-April, 1874, *Balansa 1372* (K, S); in regione cursus inferioris fl. Pilcomayo, date lacking, *Rojas 2* (B); Colonia Risso prope Rio Apa, Oct. 13–19, 1893, *Malme 1058* (BM, S).

In the relative dimensions of the calyx and corolla, exappendiculate nodes, and characteristic indument of the stem, this species appears to be quite distinct from *M. trifida*, its nearest relative evidently being the following:

4. **Mesechites acuminata** (R. & P.) Muell.-Arg. Linnaea **30:** 446. 1860.

Echites acuminata R. & P. Fl. Peruv. **2:** 19. *pl. 134.* 1799; A. DC. in DC. Prodr. **8:** 449. 1844; Miers, Apoc. So. Am. 197. 1878.

Echites trifida Jacq. f. *puberula* Mgf. Notizblatt **9:** 80. 1924.

Suffruticose lianas; stems relatively stout, minutely puberulent when young, glabrate or puberulent at the nodes when fully mature, rarely glabrous; leaves broadly oblong-elliptic to oblong-

lanceolate, apex acuminate to acute, mucronulate, base rounded, usually rather obscurely cordate, 8–12 cm. long, 3.5–7.0 cm. broad, coriaceous, either surface minutely puberulent to glabrate or glabrous; petiole 1.25–2.0 cm. long; nodal appendages mostly geminate; inflorescence much shorter than the subtending leaves, the floriferous branches about as long as the sterile primary peduncle, bearing 5–12 greenish-white, red- or purplish-flushed flowers; pedicels 1.25–1.5 cm. long, the subtending bracts minutely ovate, scarious; calyx-lobes broadly ovate-oblong, broadly obtuse to rounded, 0.4–0.5 cm. long, glabrous or essentially so; corolla salverform, the tube 2.25–2.5 cm. long, about 0.2 cm. in diameter at the base, somewhat enlarged at the insertion of the stamens, the lobes obliquely obovate-oblong, 1.5–1.75 cm. long, sharply reflexed; anthers 0.5 cm. long; ovary oblong-ovoid, about 0.3 cm. long, essentially glabrous; stigma 0.2 cm. long; nectaries compressed-ovoid, about half as long as the ovary; follicles slender, continuous, 20–30 cm. long, glabrous; seeds about 1 cm. long, the brilliantly tawny coma about 2 cm. long.

PERU: LORETO: stromgebiet des Maranons von Jquitos aufwärts bis zur Santiago-Mundung am Pongo de Manseriche, Jan. 12, 1925. *Tessmann 4918* (B); AYACUCHO: Rio Apurimac valley near Kimpitriki, alt. 400 m., edge of dense forest along beach, May 10, 1929, *Killip & Smith 22932* (US); Aina, between Huanta and Rio Apurimac, alt. 750–1000 m., May 7–17, 1929, *Killip & Smith 22741* (MBG, US); CAJAMARCA: tal des Flusses Tabaconas, zwischen dem dorfe Tabaconas und der Hacienda Charape, alt. 1500 m., May 7, 1912, *Weberbauer 6243* (B, FM, G, US); JUNIN: La Merced, alt. 700 m., thickets, May 20–June 4, 1929, *Killip & Smith 23410* (US); MAYNAS: 1831, *Poeppig 33* (V, MBG, photograph and analytical drawings); DATA INCOMPLETE: *Pavon 389* (BB, TYPE, MBG, photograph).

BOLIVIA: BENI: Guani, alt. 2000 ft., May, 1886, *Rusby 2393* (G, NY, PA); Rurrenabaque, Jan. 27, 1922, *Cardeñas 2042* (K, NY, US); LA PAZ: Tumupasa, Dec. 11, 1901, *Williams 346* (BM, NY).

5. **Mesechites Mansoana** (A. DC.) Woodson, comb. nov.

Mesechites sulphurea Muell.-Arg. in Mart. Fl. Bras. **6**[1]: 151. *pl. 46.* 1860, not *Echites sulphurea* Vell. Fl. Flum. 109. 1830; Icon. **3**: *pl. 26.* 1827.

Echites Mansoana A. DC. in DC. Prodr. **8**: 448. 1844; Miers, Apoc. So. Am. 201. 1878.

Glabrous, suffruticose lianas; stems relatively stout; leaves lanceolate- to broadly oblong-elliptic, apex rather abruptly acute to acuminate, mucronulate, base obtuse to rounded, 5–9

cm. long, 2.5–4.0 cm. broad, heavily coriaceous, either surface glabrous, the upper somewhat nitidulous; petiole 0.5–1.0 cm. long; nodal appendages mostly solitary; inflorescence one-third to one-half as long as the subtending leaves, conspicuously compound, the floriferous branches about half as long as the sterile, primary peduncle, bearing 12–30 congested, greenish-white or yellowish flowers; pedicels 0.75–1.0 cm. long, the subtending bracts minutely ovate, scarious; calyx-lobes broadly ovate-oblong, obtuse to broadly acute, 0.3–0.5 cm. long, glabrous; corolla salverform, the tube 1.75–2.0 cm. long, about 0.2 cm. in diameter at the base, somewhat enlarged at the insertion of the stamens, the lobes obliquely obovate-oblong, 0.5–0.75 cm. long, sharply reflexed; anthers 0.5 cm. long; ovary oblong-ovoid, about 0.15 cm. long, glabrous; stigma 0.2 cm. long; nectaries oblongoid, equalling or slightly longer than the ovary; follicles relatively slender, somewhat articulated, 10–15 cm. long, glabrous; seeds 0.75 cm. long, the brilliantly tawny coma 1.75 cm. long.

BRAZIL: GOYAZ: near Cauceição, Febr., 1840, *Gardner 3881* (K); MINAS GERAES: Bello Horizonte, Campo do Correo do Leitão, Febr. 6, 1919, *Gehrt 3219* (B); Lagoa Santa, in marginibus silvae, June, year lacking, *Warming s. n.* (C, S); Sabara, Jan., 1916, *Hoehne 6715* (B); exact locality lacking, 1892, *Galziou 19623* (K); SÃO PAULO: Cajuru, March 18, 1857, *Regnell 881* (S); MATTO GROSSO: Cuyaba, 1832, *Manso & Lhotzky 34* (B, DC, TYPE); Tapurapuan, March, 1909, *Hoehne 1270* (B); Cuyaba, Jan. 13, 1894, *Malme s. n.* (S); same locality, June 14–19, 1902, *Malme s. n.* (S); DATA INCOMPLETE: *Tamberlik s. n.* (V); *Warming s. n.* (C); *Riedel s. n.* (G, V).

BOLIVIA: SANTA CRUZ: Prov. Sara, alt. 450 m., Febr. 12, 1926, *Steinbach 7456* MBG, S, US).

The plate in Vellozo's 'Icones' cited above recalls the general habit of *Prestonia coalita* (Vell.) Woodson, and there appears to be little indeed to identify it with *Echites Mansoana* A. DC. as represented by Manso & Lhotzky's specimen in the de Candolle herbarium, referred to *Mesechites sulphurea* by Mueller-Argoviensis. The opposite lateral inflorescences shown in Vellozo's plate unquestionably exclude the plant depicted from the genus *Mesechites*.

6. Mesechites citrifolia (HBK.) Woodson, Ann. Mo. Bot. Gard. **19**: 387. 1932.

Echites citrifolia HBK. Nov. Gen. **3**: 216. 1819; A. DC. in DC. Prodr. **8**: 465. 1844; Miers, Apoc. So. Am. 200. 1878.

Echites brevipes Benth. Pl. Hartw. 216. 1845.
Mesechites brevipes (Benth.) Muell.-Arg. Linnaea **30**: 454. 1860.
Amblyanthera citrifolia Müll. ex Miers, loc. cit. 1878, sphalm in synon.
Mitozus brevipes (Benth.) Miers, loc. cit. 223. 1878.

Glabrous, suffruticose lianas; stems relatively stout; leaves ovate to ovate-lanceolate, acuminate, mucronulate, base broadly and rather obscurely cordate, 5–10 cm. long, 2.5–5.0 cm. broad, heavily coriaceous, either surface glabrous; petiole 0.2–0.5 cm. long; nodal appendages several; inflorescences about half as long as the subtending leaves, the floriferous branches somewhat shorter than the sterile, primary peduncle, bearing 10–25 congested, greenish-white, purple-tinged flowers; pedicels about 0.5 cm. long, somewhat accrescent at maturity, the subtending bracts minutely ovate-lanceolate, scarious; calyx-lobes ovate-lanceolate, narrowly acuminate to subsetose, 0.3–0.4 cm. long, glabrous; corolla salverform, the tube 1.25–1.5 cm. long, about 0.15 cm. in diameter at the base, somewhat enlarged at the insertion of the stamens, the lobes obliquely obovate-oblong, 0.75–1.0 cm. long, sharply reflexed; anthers 0.3 cm. long; ovary oblong-ovoid, about 0.15 cm. long, glabrous; stigma 0.15 cm. long; nectaries compressed-obovoid, about half as long as the ovary; follicles slender, conspicuously articulated or moniliform, 10–15 cm. long, glabrous; seeds 0.75 cm. long, the tawny coma about 1 cm. long.

Colombia: antioquia: thickets below Santa Barbara, alt. 900–1500 m., Sept. 21, 1922, *Pennell 10884* (NY, US); valle de cauca: Vijes, in valle fl. Cauca, alt. 1025 m., Nov., 1876, *Andre 2488* (K, MBG, photograph); bei Las Fuentes, am Rio Dagua, alt. 400 m., Aug., 1894, *Lehmann 3809* (US); cundinamarca: La Palmilla, Nov.–Dec., year lacking, *Goudot 2* (K, MBG, photograph); La Mesa, near Bogota, date lacking, *Hartweg 1195* (K, V, MBG, photograph); tolima: open slope, Libano, alt. 1000–1200 m., Dec. 26–29, 1917, *Pennell 3438* (MBG, NY, US); prope S. Ana Novogranatensium, date lacking, *Humboldt & Bonpland s. n.* (B, type).

Probably the most distinct of the continental species of *Mesechites* because of its unmistakable calyx. The numerous nodal appendages further serve to distinguish it from all its congeners.

Subgen. II. Didymadenia Woodson, n. subgen.

Corolla cream-colored or pink; foliar glands 2, fusiform, clustered radially; suffrutescent lianas of Cuba and Hispaniola. *Spp. 7–10.*

KEY TO THE SPECIES

a. Inflorescence lateral only, conspicuously compound; species of Hispaniola.
b. Corolla-tube 1.0–1.5 cm. long; leaves ovate to ovate-lanceolate. . *7. M. repens*
bb. Corolla-tube 0.4–0.6 cm. long; leaves narrowly elliptic to linear-lanceolate . . . . *8. M. angustifolia*
aa. Inflorescence both lateral and subterminal, obscurely compound; species of Cuba.
b. Corolla bright pink, the tube 2–4 cm. long . . . . *9. M. rosea*
bb. Corolla cream-colored, the tube 0.2–0.4 cm. long . . . . *10. M. minima*

7. Mesechites repens (Jacq.) Miers, Apoc. So. Am. 229. 1878.

Echites repens Jacq. Enum. Syst. Pl. Carib. 13. 1760; A. DC. in DC. Prodr. **8**: 449. 1844.

Mesechites lanceolata Miers, loc. cit. 230. 1878.

Glabrous, suffrutescent lianas; stems relatively slender; leaves ovate to ovate-lanceolate, shortly acuminate to obtuse, usually mucronulate, base rounded and very obscurely cordate, 1.5–6.0 cm. long, 0.3–2.5 cm. broad, membranaceous, glabrous without; petiole 0.1–0.6 cm. long; nodal appendages extremely inconspicuous; inflorescence lateral, conspicuously compound, much surpassing the subtending leaves, bearing 3–25 pale pink or cream-colored flowers; pedicels 0.1–0.3 cm. long, the subtending bracts minutely ovate-lanceolate; calyx-lobes narrowly lanceolate, 0.15–0.2 cm. long, glabrous; corolla salverform, the tube 1.0–1.5 cm. long, about 0.1 cm. in diameter at the base, somewhat enlarged at the insertion of the stamens, the lobes broadly obovate-dolabriform, 0.7–0.9 cm. long, widely spreading; anthers 0.15–0.2 cm. long; ovary ovoid, 0.1 cm. long, glabrous; stigma 0.15 cm. long; nectaries compressed-ovoid, somewhat shorter than the ovary; follicles slender, 15–20 cm. long, conspicuously articulated or moniliform, glabrous; seeds 0.5–0.6 cm. long, the brilliantly tawny coma about 1 cm. long.

Haiti: dry hills near l'Atalaye Plantation, vicinity of St. Michel de l'Atalaye, alt. 350 m., Nov. 18, 1925, *Leonard 7155* (NY, US); dry region northeast of U. West Indies Plantation, vicinity of St. Michel de l'Atalaye, Sept. 4, 1903, *Nash 940* (NY); rocky hillside, Bayeux, near Port Margot, Aug. 5, 1903, *Nash 158* (FM, NY); Petite Gonave Island, July 9–10, 1920, *Leonard 5251* (US); Mt. Maleuvre to Pilate, Aug. 20, 1903, *Nash 584* (NY); Petionville, alt. 1000 m., hillside, Sept. 6, 1903, *Nash 996* (NY); on sea island, Bayeux, near Port Margot, Aug. 9, 1903, *Nash 286* (FM, NY); xerophytic formation, alt. 1500 ft., San Michel, Aug. 5, 1905, *Nash & Taylor 1385* (B, NY, US); dry slope, northeast of Gros Morne, Dept. Artibonite, alt. 235 m.,

Febr. 17, 1926, *Leonard 9833* (NY, US); vicinity of Pikmi, Gonave Island, July 5–9, 1920, *Leonard 5159* (NY, US); Miragoane and vicinity, July 8, 1927, *Eyerdam 414* (MBG, US); Massif de la Selle, Port au Prince, Morne de l'Hôpital, alt. 350 m., May 20, 1927, *Ekman 8173* (B, S, US); prope Terre-Neuve, Sept. 3, 1899, *Buch 88* (B); ad Jerémie, Jan. 18, 1888, *Eggers 3389* (B); Camp-Perrin, alt. 200 m., Aug. 29, 1888, *Christ 1904* (B); Port au Prince, July, 1872, *le Jolis* (BB); vine on shrubs, road to Gros Morne, vicinity of Bassin Bleu, alt. 630–1500 m., April 15, 1929, *Leonard & Leonard 14682* (US); Camp 4, Marmelade, alt. 2775 ft., Aug. 1–2, 1905, *Nash & Taylor 1309* (NY); common in dry thickets of La Vallée valley, Tortue Island, Jan. 6, 1929, *Leonard & Leonard 11735* (NY, US); Ile La Navasse, east of the lighthouse, rare, Oct. 21, 1928, *Ekman 10835* (B, S); data incomplete, *Jaeger s. n.* (B, BB, G, K, S, US); *Ehrenberg 159* (B).

Dominican Republic: Barahona, April, 1910, *Fuertes 34* (BM, FM, G, K, NY, S, US); prope Mamial de Oco, alt. 300 m., Oct., 1910, *Tuerckheim 3605* (K, NY); Pto. Pinta, April 23, 1887, *Eggers 1638* (DL, NY, US); Santo Domingo, near the city, July, year lacking, *Schomburgk 22* (K); Haina, fence-row, Sept., 1921, *Faris 568* (US); prope Puerto Plata, in fruticosis ca. oppidium, March 30, 1887, *Eggers 1721* (B, DL, US); pine forest, San Jose de las Matas, Prov. Santiago, Aug. 26, 1929, *Valeur 96* (MBG, US); Beata Island, Febr. 23, 1922, *Ostenfeld 334* (C); data incomplete, Sept., 1909, *Tuerckheim 2586* (BM, K, NY); Jan.–March, 1871, *Wright Parry & Brummel 409* (US); 1856, *Mayerhof 28* (B).

Mesechites lanceolata Miers was founded only on the illustration of *Nerium foliis lanceolatis* Plum. Pl. Am. **1**: 20. *pl. 27*, *fig. 1*, and no specimens annotated with that name are to be found among Miers's study-specimens in the British Museum (Natural History). Although characterized by Miers as "extremely different from *M. repens*," there appears little to lead one to that conclusion either in Plumier's plate or in Miers's description. Lack of space prohibits the citation of numerous additional collections of this relatively common species.

8. **Mesechites angustifolia** (Poir.) Miers, Apoc. So. Am. 230. 1878.

Echites angustifolia Poir. Encyl. Suppl. **2**: 537. 1811; A. DC. in DC. Prodr. **8**: 449. 1844, not Benth.

Echites linearifolia Ham. Prodr. Pl. Ind. Occ. 31. 1825; A. DC. loc. cit. 1844, not Stadelm.

Mesechites linearifolia (Ham.) Miers, loc. cit. 1878.

Amblyanthera angustifolia (Poir.) Muell.-Arg. Linnaea **30**: 430. 1860.

Echites breviflora Urb. Symb. Ant. **5**: 464. 1908.

Glabrous, suffrutescent lianas; stems relatively slender; leaves narrowly elliptic- to linear-lanceolate, acuminate to subcaudate,

base obtuse or rounded, obscurely cordate, 3–10 cm. long, 0.3–2.5 cm. broad, firmly membranaceous, glabrous; petiole 0.2–0.5 cm. long; nodal appendages very inconspicuous; inflorescence lateral, conspicuously compound, equalling or somewhat surpassing the subtending leaves, bearing 2–10 congested, cream-colored flowers; pedicels 0.5–0.8 cm. long, the subtending bract minutely ovate-lanceolate; calyx-lobes narrowly trigonal, about 0.1 cm. long, glabrous; corolla salverform, the tube 0.4–0.6 cm. long, about 0.15 cm. in diameter at the base, the lobes obliquely obovate, 0.4–0.5 cm. long, widely spreading; anthers 0.2 cm. long; ovary ovoid, 0.075 cm. long, glabrous; stigma 0.15 cm. long; nectaries compressed-oblongoid, about as long as the ovary; follicles slender, 10–20 cm. long, conspicuously articulated or moniliform; seeds 0.5 cm. long, the tawny coma about 1.25 cm. long.

Haiti: dry thicket among rocks, cliff west of village, vicinity of Marmelade, alt. 800 m., Dec. 20, 1925, *Leonard 8332* (US); on shrubs in thickets, Mt. la Cidre, vicinity of St. Michel de l'Atalaye, alt. 350 m., Dec. 16, 1925, *Leonard 8048* (NY, US); hillside, near sea-level, Bayeux, near Port Margot, Aug. 4, 1903, *Nash 136* (FM, K, NY); pine woods, on low shrubs, Marmelade, alt. 3400 ft., Aug. 25, 1903, *Nash 789* (NY); Ile La Tortue, main ridge west of La Vallée, alt. 350 m., May 24, 1923, *Ekman 4116* (B, S); Dept. du Nord, prope Cap Hatien, alt. 450 m., Dec. 2, 1924, *Ekman 2725* (B, S); Port au Prince, alt. 1000 m., Aug., 1916, *Buch 1237* (B); Massif de la Selle, Nouvelle Touraine, ridges above Chapelle Taure, grassy slopes, alt. 1700 m., Aug. 22, 1924, *Ekman 1580* (S, US); twining on tree, table-land, trail to Au Palmiste, vicinity of Basse Terre, Tortue Island, March 23, 1929, *Leonard & Leonard 14013* (MBG, NY, US); climbing on shrubs, upper slope of Morne Haut Piton, vicinity of Bassin Bleu, alt. 630–1500 m., April 25, 1929, *Leonard & Leonard 15112* (US); montagnes du Trou d'Eau, hills north of Glare, on Étang Saumatre, on limestone, alt. 900 m., July 22, 1924, *Ekman 1083* (S); Massif du Nord, Cap Hatien, slope of Morne Haut du Cap, alt. 450 m., Dec. 2, 1924, *Ekman 2725* (US).

Dominican Republic: prope Puerto Plata, June 20, 1887, *Eggers 1639* (B, DL, K, NY); Barahona, hills, alt. 500 m., Sept. 1910, *Fuertes 340* (BM, K, MBG, S); Morne Bellevue, ouest de Nancivet, alt. 600–700 m., Aug. 31, 1908, *Christ 1939* (B); data incomplete, 1802, *Poiteau s. n.* (DL, S).

The type specimen of *Echites breviflora* Urb. (*Eggers 1639*) is remarkable merely because of leaves which are somewhat broader than the norm for the species. Upon the same sheet in the herbarium at Berlin-Dahlem, however, a fragment was found with the typical narrowly lanceolate foliage.

9. Mesechites rosea (A. DC.) Miers, Apoc. So. Am. 232. 1878.

Echites myrtifolia R. & S. Syst. 4: 795. 1819; A. DC. in DC. Prodr. 8: 473. 1844, not Poir.

Echites rosea A. DC. loc. cit. 450. 1844.

Mesechites myrtifolia (R. & S.) Muell.-Arg. Linnaea 30: 445. 1860; Miers, loc. cit. *pl. 33A*. 1878.

Echites torulosa Lam. ex Miers, loc. cit. 1878, nom. nud. in synon.

Nerium sarmentosum P. Browne, ex Miers, loc. cit. 1878, sphalm in synon.

Glabrous, suffrutescent lianas; stems relatively slender; leaves ovate or oval to oblong, infrequently lanceolate, apex abruptly acute to obtuse, usually mucronulate, base obtuse to rounded, obscurely cordate, 0.75–3.0 cm. long, 0.25–2.0 cm. broad, subcoriaceous, glabrous; petiole 0.1–0.2 cm. long; nodal appendages extremely inconspicuous; inflorescence lateral or subterminal, very obscurely compound, about as long as the subtending leaves when lateral, much shorter when subterminal, bearing 1–5 bright pink flowers; pedicels 0.3–0.6 cm. long, the subtending bracts minutely ovate; calyx-lobes ovate-lanceolate, acute, 0.2–0.3 cm. long, glabrous; corolla salverform, the tube 2.0–4.0 cm. long, about 0.5 cm. in diameter at the base, somewhat enlarged at the insertion of the stamens, the lobes obliquely obovate-dolabriform, 1.5–2.5 cm. long, widely spreading; anthers 0.5 cm. long; ovary ovoid, 0.1 cm. long, glabrous; stigma 0.15 cm. long; nectaries compressed ovoid-oblongoid, about as long as the ovary; follicles relatively slender, 15–45 cm. long, conspicuously articulated or moniliform; seeds 0.5–0.7 cm. long, the pale yellowish coma about 2 cm. long.

CUBA: PINAR DEL RIO: pinelands, San Gabriel to Pinal de la Catalina, Jan. 18, 1912, *Shafer 11861* (MBG, US); in grass, palm barrens west of Guane, Nov. 21–22, 1911, *Shafer 10383* (MBG, NY, US); border of lagoon, vicinity of Pinar del Rio, Sept. 5–12, 1910, *Britton Britton & Gager 6969* (NY); near Coloma, March 18, 1900, *Palmer & Riley 348* (NY, US); ISLA DE PINOS: near Nueva Gerona, Dec. 9, 1903, *Curtiss 1102* (FM); same locality, June 28, 1900, *Palmer & Riley 871* (NY, US); exact locality lacking, June 25–July 10, 1901, *Taylor 170* (FM, MBG, US); HAVANA: Lomas de las Jatas, Guanabacoa, April 19, 1914, *Ekman s. n.* (S); exact locality lacking, 1825, *Sagra 120* (DC); no data, *Drummond s. n.* (K); SANTA CLARA: Cieneguita, June 5, 1895, *Combs 138* (B, FM, K, MBG); hillside, Castillo de Jagua, Cienfuegos Bay, Febr. 25, 1910, *Britton Earle & Wilson 4598* (NY); CAMAGUEY: savanna south of Sierra Cubitas, Febr. 20–21, 1909, *Shafer 493* (NY, US); Cayo Ballenato Grande, March 18, 1909, *Shafer 941* (NY, US); vicinity of Pueblo Romano, Cayo Romano, Oct. 8–9, 1909, *Shafer 2446* (NY, US); dry soil, savannas near

Camaguey, April 2–7, 1912, *Britton Britton & Cowell 13085* (NY, US); ORIENTE: Gibara, Jan. 23, 1902, *Pollard Palmer & Palmer 2* (US); opposite Gibara to Punta Hicacos, April 21, 1909, *Shafer 1500* (NY); Santiago, Morro Hill, Febr. 3, 1899, *Millspaugh 1102* (FM); Santiago, 1899, *Havard 16* (NY); coral limestone, U. S. Naval Station, Guantanamo Bay, March 17–30, 1909, *Britton 2080* (BM, NY, US); rocky coastal hills, Cabanas Bay, March 17, 1912, *Britton & Cowell 12704* (NY); vicinity of Baracoa, Febr. 1–7, 1902, *Pollard Palmer & Palmer 248* (MBG, US); "The Ovens," Santiago, Febr. 4, 1899, *Millspaugh 1113* (FM); La Magdalena, Cayamas, Sept. 5, 1907, *Earle & Baker 2451* (B, NY); in collibus calcar. siccis ad Aguadores, prope Santiago, Nov. 4, 1917, *Ekman 8698* (S); Sierra de Nipe ad bas. mont. Loma Mensura in pinetis, Oct. 19, 1914, *Ekman 3196* (S); DATA INCOMPLETE: *Wright 1662* (BB, Bx, BM, G, K, MBG).

10. **Mesechites minima** (Britton & Wilson) Woodson, Ann. Mo. Bot. Gard. **19**: 386. 1932.

Echites minima Britton & Wilson, Mem. Torrey Bot. Club **16**: 94. 1920.

Glabrous, suffrutescent lianas; stems relatively slender; leaves oblong to ovate-oblong, apex obtuse to rounded, rarely acute, mucronulate, base rounded and very obscurely cordate, 0.4–2.0 cm. long, 0.2–0.6 cm. broad, subcoriaceous, glabrous; petiole about 0.1 cm. long; nodal appendages obsolete; inflorescence both lateral and subterminal, very obscurely compound, somewhat longer than the subtending leaves, bearing 1–5 cream-colored flowers; pedicels 0.1–0.3 cm. long, the subtending bracts minutely ovate; calyx-lobes narrowly trigonal, somewhat less than 0.1 cm. long, glabrous; corolla salverform, the tube 0.2–0.4 cm. long, about 0.1 cm. in diameter at the base, the lobes obliquely obovate, 0.2 cm. long, widely spreading; anthers 0.1 cm. long, glabrous; ovary ovoid, about 0.075 cm. long, glabrous; stigma about 0.05 cm. long; nectaries compressed-ovoid, somewhat shorter than the ovary; mature follicles unknown.

CUBA: SANTA CLARA: palm barren, Motembo, Jan. 4, 1919, *Leon & Fortun 8649* (NY); wet sandy savanna, near Mordazo, Dec. 29, 1915, *Leon & Cazanas 5974* (NY); CAMAGUEY: Loma de la Guana Maguilla, east of Camaguey City, Aug. 25, 1925, *Acuna 3795* (NY); moist places, climbing over grass, savanna, Queen City to Minas, Nov. 21, 1909, *Shafer 2928* (NY); prope Santayana, in palmcetis, Oct. 4, 1922, *Ekman 15334* (B, S); ORIENTE: in dry grassy place, barren savannas, southeast of Holguin, Nov. 26–29, 1909, *Shafer 2955* (NY); prope Holguin, in mont. Cerro de Fraile, Oct. 28, 1914, *Ekman 3231* (B, S).

The parallelism of the floras of Cuba and Hispaniola is strikingly illustrated by the four species of subgen. *Didymadenia*, a large-

flowered, common species, and a very small-flowered, rarer species occurring upon either island, and bearing much the same relationship to each other in morphology and habitat.

Excluded or Uncertain Species

Mesechites torulosa (L.) Miers, Apoc. So. Am. 229. 1878 = **Mandevilla torosa** (Jacq.) Woodson, Ann. Mo. Bot. Gard. **19:** 64. 1932.

Mesechites angustata Miers, loc. cit. 231. 1878 = **Mandevilla Benthamii** (A. DC.) K. Sch. in Engl. & Prantl, Nat. Pflanzenfam. **4**²**:** 171. 1895.

Mesechites subcarnosa (Benth.) Miers, loc. cit. 1878 = **Mandevilla subcarnosa** (Benth.) Woodson, in Gleason, Bull. Torrey Bot. Club **58:** 453. 1931.

Mesechites Brownei (A. DC.) Miers, loc. cit. 232. 1878 = **Mandevilla torosa** (Jacq.) Woodson, Ann. Mo. Bot. Gard. **19:** 64. 1932.

Mesechites hastata Miers, loc. cit. 233. 1878 = **Mandevilla subsagitatta** (R. & P.) Woodson, loc. cit. 69. 1932.

Mesechites dichotoma (HBK.) Miers, loc. cit. 1878 (*Echites dichotoma* HBK. Nov. Gen. **3:** 217. 1819). The type specimen of this species has not been found for examination. From the description, the identity of the plant might be guessed as *Mesechites trifida* (Jacq.) Muell.-Arg., but the latter species is at present unreported from the neighborhood of Quito, from which the former is said by Kunth to have come. *M. trifida* has been collected upon several occasions in the Province of Guayas, however.

Mesechites Guayaquilensis (Benth.) Miers, loc. cit. 1878 = **Mandevilla subsagittata** (R. & P.) Woodson, loc. cit. 69. 1932.

Mesechites hirtella (HBK.) Miers, loc. cit. 234. 1878 = **Mandevilla subsagittata** (R. & P.) Woodson, loc. cit. 1932.

Mesechites Oaxacana (A. DC.) Miers, loc. cit. 1878 = **Mandevilla oaxacana** (A. DC.) Hemsl. Biol. Centr.-Am. Bot. **2:** 316. 1882.

Mesechites hirtellula Miers, loc. cit. 1878 = **Mandevilla oaxacana** (A. DC.) Hemsl. loc. cit. 1882.

Mesechites jasminiflora (Mart. & Gal.) Miers, loc. cit. 235.

1878 = **Mandevilla subsagittata** (R. & P.) Woodson, loc. cit. 1932.

Mesechites Andrieuxii (Muell.-Arg.) Miers, loc. cit. 1878 = **Mandevilla Andrieuxii** (Muell.-Arg.) Hemsl. loc. cit. 1882.

Mesechites Guianensis (A. DC.) Miers, loc. cit. 1878 = **Mandevilla subspicata** (Vahl) Mgf. Rec. Trav. Bot. Néerl. **22:** 380. 1926.

III. MANDEVILLA Lindl.[18]

Mandevilla Lindl. Bot. Reg. n. s. **3:** *pl. 7.* 1840; Benth. & Hook. Gen. Pl. **2:** 726. 1876; Miers, Apoc. So. Am. 184. 1878; K. Sch. in Engl. & Prantl, Nat. Pflanzenfam. **4**^{2}**:** 170. 1895; Dalla Torre & Harms, Gen. Siphon. 6659. 1904.

Exothostemon G. Don, Gen. Hist. Dichlam. Pl. **4:** 82. 1838; Miers, loc. cit. 238. 1878, in part.

Laseguea A. DC. in DC. Prodr. **8:** 481. 1844; ibid. Ann. Sci. Nat. Bot. III. **1:** 260. 1844; Muell.-Arg. in Mart. Fl. Bras. **6**^{1}**:** 134. 1860; Benth. & Hook. loc. cit. 725. 1876; Miers, loc. cit. 248. 1878; Baill. Hist. Pl. **10:** 216. 1891; K. Sch. loc. cit. 171. 1895; Dalla Torre & Harms, loc. cit. 6660. 1904.

Dipladenia A. DC. loc. cit. 1844; Muell.-Arg. loc. cit. 120. 1860; Benth. & Hook. loc. cit. 726. 1876; Miers, loc. cit. 153. 1878; K. Sch. loc. cit. 168. 1895.

Heterothrix Muell.-Arg. loc. cit. 133. 1860; Miers, loc. cit. 264. 1878.

Amblyanthera Muell.-Arg. loc. cit. 141. 1860; Miers, loc. cit. 185. 1878, not Blume.

Eriadenia Miers, loc. cit. 117. 1878; Baill. loc. cit. 218. 1891; Dalla Torre & Harms, loc. cit. 6649. 1904.

Micradenia Miers, loc. cit. 158. 1878.

Homaladenia Miers, loc. cit. 164. 1878.

Angadenia Miers, loc. cit. 173. 1878, in part.

[18] A motion to retain the name *Mandevilla* Lindl. when that genus shall be considered as congeneric with *Exothostemon* G. Don. has been indorsed by Dr. Fr. Markgraf, Berlin-Dahlem, and the writer and forwarded to the International Committee on Genera Conservanda in care of Dr. T. A. Sprague, Kew. This motion reviewed in detail (1) the popularity of *Mandevilla* and the disuse of *Exothostemon;* (2) the confusion relative to the use of the latter genus; (3) and particularly the large number of nomenclatorial changes which would be involved in the resurrection of the older name.

Temnadenia Miers, loc. cit. 207. 1878, in part.
Echites of many authors, in part, not P. Br.

Lactescent, suffruticose or suffrutescent lianas, undershrubs, and herbs. Stems volubile, ascending, or erect, terete or alate; branches usually opposite below, becoming alternate above. Leaves opposite or verticillate, the ventral surface bearing several inconspicuous, glandular emergences clustered at the base or distributed along the length of the midrib, rarely eglandular; petioles usually somewhat girdling at the node into an appendiculate, stipular ring. Inflorescence predominantly lateral, occasionally terminal or subterminal, racemose, simple or very rarely obscurely compound, bracteate, multiflorous to subuniflorous. Calyx 5-parted, the lobes equal or subequal, cleft nearly to the receptacle, imbricated, bearing within 5–many opposite, alternate, or indefinitely and uniformly distributed squamellae. Corolla infundibuliform, salverform, or tubular-salverform, the tube straight or somewhat gibbous, the limb actinomorphic, 5-parted, dextrorsely convolute. Stamens 5, the anthers connivent and agglutinated to the stigma, consisting of 2 parallel, uniformly fertile sporangia borne ventrally near the apex of an enlarged, sagittate, truncate or obtusely 2-auriculate, peltate connective; pollen granular; filament short, subcylindrical, usually densely puberulent. Carpels 2, united at the apex by an elongate, stylar shaft surmounted by the pentagonal-umbraculiform stigma; ovules many, several-seriate, borne upon an axile, binate placenta. Nectaries 2–5, rarely obsolete, separate or somewhat concrescent at the base. Follicles 2, apocarpous, terete, dehiscing along the ventral suture, containing many dry, subscaphiform, truncate, apically comose seeds.

Type species: *Mandevilla laxa* (R. & P.) Woodson, Ann. Mo. Bot. Gard. **19**: 68. 1932.

KEY TO THE SUBGENERA AND SECTIONS

A. Corolla-tube straight, not gibbous or arcuate; squamellae predominantly numerous, in groups alternate with the calyx-lobes or indefinitely and uniformly distributed (solitary and opposite the calyx-lobes in *M. funiformis*); upper surface of leaves glandular at the base of the midrib, or eglandular (sparsely glandular along the midrib in *M. congesta* and *M. callista*)..............................Subgen. I. EUMANDEVILLA

B. Corolla salverform or tubular-salverform.
  C. Anthers auriculate.
    D. Nectaries 5.
      E. Nectaries equalling or somewhat surpassing the ovary; lianas of Mexico and Central America..............Sect. 1. TUBIFLORAE
      EE. Nectaries shorter than the ovary (equalling them in *M. apocynifolia*); low twiners of Jamaica and suffrutescent herbs of Mexico..................................Sect. 2. TOROSAE
    DD. Nectaries 2; species of South America..........Sect. 4. TENUIFOLIAE
  CC. Anthers truncate, or merely somewhat emarginate or concave at the base; species of South America................Sect. 3. MONTANAE
BB. Corolla infundibuliform.................................Sect. 5. LAXAE
AA. Corolla-tube more or less gibbous or arcuate; squamellae as many as the calyx-lobes and opposite them, frequently deeply lacerate (see also *M. funiformis*); upper surface of leaves glandular along the midrib (see also *M. congesta* and *M. callista*)..................Subgen. II. EXOTHOSTEMON

Subgen. I. EUMANDEVILLA Woodson, n. subgen.

Corolla-tube straight, not gibbous or arcuate; squamellae predominantly numerous, in groups alternate with the calyx-lobes, or indefinitely and uniformly distributed (or solitary and opposite the calyx-lobes in *M. funiformis*); upper surface of leaves bearing few to several glandular emergences clustered at the base of the midrib, or eglandular in certain species (sparsely glandular along the midrib in *M. congesta* and *M. callista*). *Sects. 1–5.*

Sect. 1. TUBIFLORAE Woodson. Corolla salverform or tubular-salverform; nectaries 5, equalling or somewhat surpassing the ovary; anthers oblong to oblong-lanceolate, conspicuously auriculate; lianas of Mexico and Central America. *Spp. 1–8.*

KEY TO THE SPECIES

a. Corolla strictly salverform, the limb conspicuous and definitely reflexed or spreading.
  b. Stamens inserted near the orifice of the corolla-tube, the anthers with truncate auricles.
    c. Calyx-lobes uniform or essentially so, relatively inconspicuous, much shorter than the corolla-tube.
      d. Inflorescence not secund; leaves lanceolate to oblong-lanceolate.
        e. Corolla-lobes obovate, about ¼ as long as the tube; leaves pubescent, at least beneath...........................*1. M. tubiflora*
        ee. Corolla-lobes oblong-lanceolate, about ⅙ as long as the tube; leaves glabrous..............................*2. M. acutiloba*
      dd. Inflorescence secund; leaves broadly ovate to ovate-oblong...... ....*3. M. Donnell-Smithii*

cc. Calyx-lobes unequal and very conspicuous, about half as long as the corolla-tube .... *4. M. platydactyla*

bb. Stamens inserted about midway within the corolla-tube, the anthers with rounded auricles.

c. Inflorescence neither secund nor subscorpioid; leaves lanceolate, glabrous .... *5. M. Rosana*

cc. Inflorescence secund and subscorpioid; leaves ovate to ovate-lanceolate, pubescent to glabrate above .... *6. M. subscorpioidea*

aa. Corolla tubular-salverform, the limb relatively inconspicuous, erect or nearly so, not reflexed or spreading.

b. Inflorescence typically racemose, about as long as the subtending leaves, or somewhat longer; calyx-lobes 0.2–0.3 cm. long, acute to broadly acuminate .... *7. M. Syrinx*

bb. Inflorescence corymbose or subumbellate, shorter than the subtending leaves; calyx-lobes 0.4–0.6 cm. long, long-acuminate to subulate.... .... *8. M. sertuligera*

1. **Mandevilla tubiflora** (Mart. & Gal.) Woodson, Ann. Mo. Bot. Gard. **19**: 52. 1932.

Echites tubiflora Mart. & Gal. Bull. Acad. Roy. Brux. **11**[1]: 358. 1844; Miers, Apoc. So. Am. 206. 1878.

Amblyanthera tubiflora (Mart. & Gal.) Muell.-Arg. Linnaea **30**: 423. 1860.

Echites Cobanensis Donn. Sm. Bot. Gaz. **40**: 6. 1905.

Suffruticose lianas; stems terete, relatively slender, minutely puberulent when young, eventually becoming glabrate; leaves opposite, petiolate, lanceolate to oblong-lanceolate, acuminate, obscurely cordate, 4–10 cm. long, 0.75–4.0 cm. broad, membranaceous, upper surface minutely puberulent to glabrate, glandular at the base of the midrib, lower surface densely tomentulose; petiole 0.4–1.0 cm. long; nodal appendages inconspicuous; inflorescence lateral, or occasionally subterminal, simply racemose, about as long as the subtending leaves, bearing 8–20 yellowish flowers; pedicels 0.75–1.0 cm. long, the subtending bracts lanceolate to filiform, about 0.2 cm. long; calyx-lobes ovate to ovate-lanceolate, acute to acuminate, 0.1–0.2 cm. long, scarious, minutely puberulent to glabrate, the squamellae in alternate groups of 5–6, or uniformly distributed; corolla salverform, glabrous without, the tube straight, 1.0–1.5 cm. long, about 0.1 cm. in diameter at the base, the lobes obliquely obovate, 0.25–0.35 cm. long, spreading; stamens inserted near the orifice of the corolla-tube, the anthers 0.3 cm. long, basal auricles

truncate; ovary ovoid, glabrous, about 0.075 cm. long; stigma 0.25 cm. long; nectaries 5, compressed-oblongoid, as long as the ovary or somewhat longer; follicles unknown.

MEXICO: VERA CRUZ: Zacuapan and vicinity, Nov., 1906, *Purpus 1935* (B, FM, G, MBG, NY, US); hillsides, Zacuapan, July, 1926, *Purpus 10790* (US); Mirador til Huatusco, Sept., 1841, *Liebmann 11978* (C); Mirador, Nov., 1841, *Liebmann 11960* (C); same locality, Oct., 1841, *Liebmann 11959* (C); OAXACA: near Xalapa, alt. 3000 ft., Oct., 1841, *Galeotti 1579* (K, TYPE, MBG, photograph and analytical drawings); YUCATAN: exact locality and date lacking, *Gaumer 23969* (FM, US); DATA INCOMPLETE: *Ghiesbreght 148* (B, BB).

GUATEMALA: ALTA VERAPAZ: Coban, alt. 1400 m., Aug., 1904, *Tuerckheim 8709* (US); in Gebüschen windend, same locality, June, 1907, *Tuerckheim II 1816* (Bx, G, NY, US, V); same locality, July, 1912, *Tuerckheim 2448* (US); Samac, alt. 4000 ft., July 26, 1920, *H. Johnson 410* (US).

Until the present time, Martens & Galeotti's specific name has been wrongly applied to the plants correctly referable to *M. Syrinx* and *M. sertuligera*, as a result of insufficiency in the original description and inaccessibility of authentic specimens. In the course of this study, however, the type specimen of *E. tubiflora*, or a duplicate of the type (*Galeotti 1579*), was found among the collection of undetermined Apocynaceae in the herbarium of the Royal Botanic Gardens, Kew, which fortunately gives a definite status to the species. This would appear to be the only surviving specimen of the collection, as it was not found in the herbarium of the Jardin Botanique de l'État, Brussels, with the bulk of Galeotti's specimens.

2. **Mandevilla acutiloba** (A. DC.) Woodson, Ann. Mo. Bot. Gard. **19**: 54. 1932.

Echites acutiloba A. DC. in DC. Prodr. **8**: 451. 1844; Miers, Apoc. So. Am. 198. 1878.

Amblyanthera acutiloba (A. DC.) Muell.-Arg. Linnaea **30**: 426. 1860.

Suffruticose lianas; stems terete, relatively slender, glabrous; leaves opposite, petiolate, lanceolate to broadly elliptic-lanceolate, acuminate, obscurely cordate, 5–8 cm. long, 1.5–3.0 cm. broad, membranaceous, either surface glabrous, the upper glandular at the base of the midrib; petiole 0.75–2.0 cm. long; nodal appendages minute; inflorescence lateral, simply racemose, about as long as the subtending leaves, bearing 7–12 yellowish flowers; pedicels

1.75–2.0 cm. long, glabrous; bracts lanceolate to linear-lanceolate, 0.2–0.5 cm. long; calyx-lobes lanceolate to oblong-lanceolate, acuminate, 0.25–0.5 cm. long, scarious, glabrous, the squamellae in alternate groups of 4–6, or uniformly distributed; corolla salverform, glabrous without, the tube straight, 1.5–1.75 cm. long, about 0.2 cm. in diameter at the base, the lobes obliquely oblong-lanceolate, acuminate, about 0.5 cm. long, spreading; stamens inserted near the orifice of the corolla-tube, the anthers 0.4 cm. long, basal auricles truncate; ovary ovoid, about 0.1 cm. long, glabrous; stigma 0.2 cm. long; nectaries 5, compressed-oblongoid, equalling or somewhat surpassing the ovary; follicles unknown.

MEXICO: CHIAPAS: near Tumbala, alt. 4000–5500 ft., Oct. 20, 1895, *Nelson 3337* (US); DATA INCOMPLETE: *Pavon s. n.* (BB, TYPE, MBG, photograph and analytical drawings).

The Nelson specimen does not quite agree with that of Pavon. The leaves are somewhat more attenuate, the calyx-lobes are shorter, the corolla-lobes are more nearly oblong, and the nectaries equal the ovary in the former, whereas they somewhat surpass the ovary in the latter. In time, the specimens may be interpreted as representing distinct species, but such a view must be reinforced by a study of additional specimens to establish the range of variability of the plants.

3. **Mandevilla Donnell-Smithii** Woodson, Ann. Mo. Bot. Gard. **19**: 54. 1932.

Suffruticose lianas; stems terete, relatively slender, puberulent; leaves opposite, petiolate, ovate to ovate-oblong, apex acute to acuminate, rarely somewhat obtuse, base abruptly rounded, cordate, 4–10 cm. long, 2–8 cm. broad, membranaceous, upper surface hirtellous, glandular at the base of the midrib, lower surface densely tomentulose; petiole 0.75–2.5 cm. long; nodal appendages minute; inflorescence lateral or occasionally subterminal, simply racemose, equalling or somewhat exceeding the subtending leaves, bearing 10–25 secund, yellowish flowers; pedicels 0.5–0.75 cm. long; bracts narrowly lanceolate to flagelliform, 0.2–0.4 cm. long, scarious; calyx-lobes ovate to ovate-lanceolate, acute to acuminate, 0.3–0.4 cm. long, scarious,

minutely puberulent, the squamellae very numerous, indefinitely distributed; corolla salverform, glabrous without, the tube straight, 1.25–1.5 cm. long, about 0.15 cm. in diameter at the base, the lobes obliquely obovate, 0.25–0.4 cm. long, spreading; stamens inserted near the orifice of the corolla-tube, the anthers 0.3 cm. long, basal auricles truncate; ovary ovoid, about 0.1 cm. long, glabrous; stigma 0.2 cm. long; nectaries 5, compressed-ovoid, equalling or slightly surpassing the ovary; follicles unknown.

GUATEMALA: BAJA VERAPAZ: Cuesta de Cachil, alt. 1200–1600 m., near Salama, April 21, 1905, *Pittier 144* (US); Santa Rosa, alt. 5000 pp., im Walde, July, 1887, *Tuerckheim 1276* (US); SACATEPEQUES: Santiago, alt. 6500 pp., 1891, *Gomez 777* (K, US); SANTA ROSA: Cerro Gordo, alt. 3500 pp., Aug., 1892, *Heyde & Lux 3993* (B, G, TYPE, K, NY, US, MBG, photograph and analytical drawings); DATA INCOMPLETE: *Heyde 749* (US); *Heyde 152* (US).

Superficially, this species may be distinguished from *M. tubiflora*, with which it is most likely to be confused, by its secund inflorescence and broader foliage. In addition, the inflorescence of the former is much more compact than that of the latter, and is usually somewhat more floriferous.

4. **Mandevilla platydactyla** Woodson, Ann. Mo. Bot. Gard. **19**: 55. 1932.

Suffruticose lianas; stems relatively slender, terete, densely tomentose when young, eventually becoming glabrate; leaves opposite, shortly petiolate, ovate to oblong-obovate, apex acute to acuminate, base obscurely cordate, 5–10 cm. long, 2–5 cm. broad, membranaceous, upper surface densely hirtellous to glabrate, glandular at the base of the midrib, lower surface tomentose; petiole 0.2–0.4 cm. long; nodal appendages inconspicuous; inflorescence lateral or occasionally subterminal, simply racemose, somewhat shorter than the subtending leaves, bearing 10–25 yellowish flowers; pedicels 0.8–1.0 cm. long; bracts ovate to ovate-oblong, 0.3–0.6 cm. long; calyx-lobes ovate-oblong, abruptly acute to obtuse, 0.6–0.8 cm. long, minutely tomentulose to glabrate, the squamellae indefinitely distributed; corolla salverform, glabrous without, the tube straight, 1.25–1.5 cm. long, about 0.25 cm. in diameter at the base, the lobes obliquely obovate, 0.4–0.5 cm. long, spreading; stamens inserted near the

orifice of the corolla-tube, the anthers 0.5 cm. long, basal auricles truncate; ovary ovoid, about 0.1 cm. long, puberulent; stigma 0.2 cm. long; nectaries 5, compressed-ovoid, about equalling the ovary; follicles falcate, continuous, about 25 cm. long, glabrate; seeds 1 cm. long, the pale tawny coma about 2 cm. long.

MEXICO: OAXACA: entre El Ladron y Plan de Minas, Juquila, alt. 1500 m., Dec. 28, 1921, *Conzatti 4541* (US); Tolaga, June, 1842, *Liebmann 11986* (C, TYPE, MBG, photograph and analytical drawings).

M. platydactyla is unique among its neighboring species because of its peculiar laminate calyx-lobes, recalling the appearance of the foliaceous calyx of the Candollean genus *Laseguea* as misinterpreted by Miers. From its immediate relatives the species also differs in the deeper sinuation of the anther auricles.

5. **Mandevilla Rosana** (Donn. Sm.) Woodson, Ann. Mo. Bot. Gard. **19**: 56. 1932.

Echites Rosana Donn. Sm. Bot. Gaz. **40**: 6. 1905.

Suffruticose lianas; stems terete, relatively slender, glabrous, or sparsely and minutely puberulent when very young; leaves opposite, petiolate, lanceolate to narrowly ovate-lanceolate, acuminate, abruptly and obscurely cordate, 6–12 cm. long, 1.5–3.0 cm. broad, firmly membranaceous, glabrous, upper surface glandular at the base of the midrib; petiole 0.3–0.5 cm. long; nodal appendages very inconspicuous; inflorescence lateral or subterminal, simply racemose, equalling or slightly surpassing the subtending leaves, bearing 6–15 yellowish flowers; pedicels 0.7–1.0 cm. long; bracts narrowly lanceolate to linear, 0.5–0.7 cm. long; calyx-lobes ovate-lanceolate, 0.3–0.4 cm. long, glabrous, the squamellae in alternate groups of 5–6; corolla salverform, glabrous without, the tube straight, 1.5 cm. long, about 0.2 cm. in diameter at the base, the lobes obliquely obovate-oblong, 0.6–0.7 cm. long, spreading; stamens inserted about midway within the corolla-tube, the anthers 0.4 cm. long, auricles rounded; ovary ovoid, 0.1 cm. long, glabrous; stigma 0.4 cm. long; nectaries 5, compressed-oblongoid, equalling the ovary; follicles unknown.

GUATEMALA: SANTA ROSA: Buena Vista, alt. 1000 m., April, 1893, *Heyde & Lux 4540* (B, G, K, US, TYPE, MBG, photograph and analytical drawings).

Known only from the type locality. Abundant differences separate it from the following, however, as the key to species indicates.

6. **Mandevilla subscorpioidea** Woodson, Ann. Mo. Bot. Gard. 19: 56. 1932.

Suffruticose lianas; stems terete, relatively slender, hirtellous, eventually becoming glabrate; leaves opposite, petiolate, ovate to ovate-lanceolate, apex acuminate, base abruptly and narrowly cordate, 4–14 cm. long, 1.5–7.0 cm. broad, membranaceous, above hirtellous or hispidulous to glabrate, glandular at the base of the midrib, beneath densely tomentulose; petiole 0.4–1.0 cm. long; nodal appendages inconspicuous; inflorescence lateral, simply racemose, equalling or greatly surpassing the subtending leaves, bearing 15–40 secund, yellowish or orange-tinted flowers; pedicels 0.75–1.0 cm. long; bracts linear-lanceolate, 0.5–0.75 cm. long, scarious; calyx-lobes lanceolate, acuminate, 0.4 cm. long, scarious, sparsely hirtellous to glabrate, the squamellae indefinitely distributed; corolla salverform, glabrous without, the tube straight, 1.5–2.0 cm. long, about 0.1 cm. in diameter at the base, the lobes obliquely obovate, 0.4–0.5 cm. long, spreading; stamens inserted about midway within the corolla-tube, the anthers 0.4 cm. long, the auricles rounded; ovary ovoid, about 0.1 cm. long, glabrous; stigma 0.4 cm. long; nectaries 5, compressed-oblongoid, equalling or slightly surpassing the ovary; follicles unknown.

MEXICO: CHIAPAS: Cerro de Boqueron, June, 1914, *Purpus 7274* (BM, G, MBG, TYPE, US).

GUATEMALA: ALTA VERAPAZ: im Gebüschen windend, Coban, alt. 1350 m., June, 1907, *Tuerckheim 1829* (FM, G, NY, US).

These two specimens are not identical, and may be found to represent distinct species or varieties when additional material is available for study. *Purpus 7274* has somewhat longer, narrower calyx-lobes, which are sparsely pilose or hirtellous, the bracts are longer, as are also the leaves, and the floral buds are relatively blunt. *Tuerckheim 1829* has shorter calyx-lobes which are merely somewhat ciliate, also shorter bracts and leaves, and the floral buds are more sharp than in the preceding.

7. **Mandevilla Syrinx** Woodson, Ann. Mo. Bot. Gard. 19: 53. 1932.

Suffruticose lianas; stems terete, relatively slender, puberulent, eventually becoming glabrate; leaves opposite, shortly petiolate, elliptic-ovate to oblong-lanceolate, shortly acuminate, narrowly cordate, 5–14 cm. long, 1.5–8.0 cm. broad, above minutely hispidulous to glabrate, glandular at the base of the midrib, beneath finely tomentulose or puberulent to glabrate; petiole 0.5–1.0 cm. long; nodal appendages very inconspicuous; inflorescence lateral or subterminal, simply racemose, equalling or somewhat surpassing the subtending leaves, bearing 15–60 congested, yellowish flowers; pedicels 0.3–0.4 cm. long; bracts ovate-lanceolate, 0.2–0.3 cm. long, scarious; calyx-lobes ovate-trigonal, acute to broadly acuminate, 0.2–0.3 cm. long, scarious, glabrous or minutely puberulent-papillate, the squamellae indefinitely distributed; corolla tubular-salverform, glabrous without, the tube straight, 0.5–0.75 cm. long, about 0.3–0.4 cm. in diameter at the base, the lobes obliquely ovate, about 0.4 cm. long, erect or nearly so; stamens inserted about midway within the corolla-tube, the anthers 0.4 cm. long, auricles truncate; ovary ovoid, about 0.2 cm. long, glabrous; stigma 0.3–0.4 cm. long; nectaries 5, compressed-oblongoid, equalling or slightly surpassing the ovary; follicles falcate or somewhat divaricate, continuous, 15–25 cm. long, glabrous; seeds about 0.75 cm. long, the pale yellowish coma about 1.5 cm. long.

MEXICO: GUANAJUATO: Piesa de la Olla a Guanajuato, May, 1897, *Duges 90* (G, US); Guanajuato, 1880, *Duges s. n.* (G); JALISCO: barranca, near Guadalajara, date lacking, *Palmer 98* (G, US); barranca of Tequila, Oct. 8, 1893, *Pringle 5422* (B, G, MBG, TYPE); MORELOS: lava-beds, near Cuernavaca, alt. 5000 ft., June 23–Sept. 15, 1896, *Pringle 6329* (B, BB, BM, Bx, DL, G, K, MBG, NY, S, US, V).

8. **Mandevilla sertuligera** Woodson, Ann. Mo. Bot. Gard. 19: 383. 1932.

Suffruticose lianas; stems terete, relatively slender, minutely hispidulous to puberulent, eventually becoming glabrate; leaves opposite, petiolate, elliptic-ovate, apex abruptly acuminate, base obscurely cordate, 6–8 cm. long, 3.0–3.5 cm. broad, membranaceous, above hispidulous to strigillose, glandular at the base of the midrib, beneath densely lanate-tomentose; petiole 0.75–1.25 cm. long; nodal appendages very inconspicuous; inflorescence lateral or subterminal, corymbose to subumbellate, about half

as long as the subtending leaves, bearing 10–45 congested, yellowish flowers; pedicels 0.3–0.4 cm. long; bracts linear, about as long as the pedicels; calyx-lobes narrowly lanceolate, acuminate to subulate, 0.4–0.6 cm. long, scarious, minutely pilosulose, the squamellae indefinitely distributed; corolla tubular-salverform, glabrous without, the tube straight, 0.75 cm. long, about 0.3 cm. in diameter at the base, the lobes obliquely ovate, 0.3–0.4 cm. long, erect or nearly so; stamens inserted about midway within the corolla-tube, the anthers 0.4 cm. long, auricles obtuse; ovary ovoid, about 0.15 cm. long, puberulent-papillate; stigma 0.4 cm. long; nectaries 5, compressed-oblongoid, slightly surpassing the ovary; follicles unknown.

MEXICO: MICHOACAN: rocky hills near Coru Station, alt. 6000 ft., Jan. 23, 1907, *Pringle 13890* (G, US, TYPE, MBG, photograph and analytical drawings); same locality, Oct. 15, 1904, *Pringle 13106* (B, C, G, K, US); MORELOS: near Cuernavaca, July 10, 1898, *Pringle s. n.* (C); OAXACA: exact locality lacking, alt. 6000 pp., date lacking, *Galeotti 1604* (DL).

This species, together with *M. Syrinx*, forms a distinctive element in the Mexican and Central American representation of the genus which strikingly resembles *M. brachyloba*, *M. cercophylla*, and the closely related *M. erecta* and *M. Pentlandiana* of South America, in the inconspicuous, erect corolla-lobes. The latter four species, however, differ from the preceding in the truncate anthers, which serve to distinguish § *Montanae* from the superficially similar § *Tubiflorae*. Several of the specimens cited for both *M. Syrinx* and *M. sertuligera* exhibit slight differences in the quality of the indument which may eventually lead to varietal segregation.

Sect. 2. TOROSAE Woodson. Corolla salverform; nectaries 5, shorter than the ovary (or barely equalling them in *M. apocynifolia*); anthers broadly ovate-oblong to oblong-lanceolate, conspicuously auriculate; low twiners of Jamaica and suffrutescent herbs of Mexico. *Spp. 9–13.*

KEY TO THE SPECIES

a. Racemes subcorymbose; nectaries shorter than the ovary.
  b. Plants twining or trailing (occasionally suberect in *10*); stamens inserted about midway within the corolla-tube.
    c. Plants twining, infrequently trailing; leaves elliptic; corolla-tube 0.4–0.6 cm. long; follicles moniliform; plants of Jamaica and Yucatan..*9. M. torosa*

cc. Plants trailing or suberect, infrequently somewhat twining; leaves oblanceolate or narrowly spathulate; corolla-tube 0.7–0.9 cm. long; follicles essentially continuous; plants of southeastern Mexico. .... *10. M. Karwinskii*

bb. Plants erect or essentially so; stamens inserted above the middle of the corolla-tube.

c. Corolla-lobes obliquely oblong-obovate, shorter than the tube; leaves 6–15 cm. long, minutely and generally pilose beneath...... *11. M. foliosa*

cc. Corolla-lobes obliquely obovate, about as long as the tube; leaves 2–5 cm. long, minutely puberulent along the midrib beneath.. *12. M. mexicana*

aa. Racemes relatively elongate; nectaries about as long as the ovary....... .... *13. M. apocynifolia*

9. **Mandevilla torosa** (Jacq.) Woodson, Ann. Mo. Bot. Gard 19: 64. 1932.

Echites torosa Jacq. Enum. Syst. Pl. Carib. 13. 1760; *ibid.* Stirp. Am. 1: 33. *pl. 27.* 1763; A. DC. in DC. Prodr. 8: 449. 1844; Griseb. Fl. Br. W. Ind. 413. 1861.

Echites torulosa L. Sp. Pl. ed. 2. 307. 1762; Griseb. loc. cit. 414. 1861.

Echites torosa Jacq. var. *Brownei* A. DC. loc. cit. 1844.

Amblyanthera torosa (Jacq.) Muell.-Arg. Linnaea 30: 446. 1860.

Echites Brownei (A. DC.) Muell.-Arg. loc. cit. 1860; Griseb. loc. cit. 414. 1861.

Mesechites torulosa (L.) Miers, Apoc. So. Am. 229. 1878.

Mesechites Brownei (A. DC.) Miers, loc. cit. 232. 1878.

Suffrutescent twiners, occasionally somewhat trailing; stems terete, relatively slender, puberulent when young, usually becoming glabrate; leaves opposite, shortly petiolate, elliptic, apex acute to acuminate, base gradually narrowed and obscurely cordate, 2–7 cm. long, 0.75–3.0 cm. broad, firmly membranaceous to subcoriaceous, usually glabrous, infrequently minutely pilose, above sparsely glandular at the base of the midrib; petiole 0.15–0.4 cm. long; nodal appendages minute; inflorescence lateral, corymbose or subcorymbose, about as long as the subtending leaves, bearing 3–12 white or cream-colored flowers; pedicels 0.75–1.0 cm. long; bracts lanceolate, 0.1–0.4 cm. long, scarious; calyx-lobes lanceolate-trigonal, acuminate, 0.15–0.2 cm. long, scarious, glabrous, the squamellae in alternate groups of 4–5; corolla salverform, glabrous without, the tube straight, 0.4–0.6

cm. long, about 0.1 cm. in diameter at the base, the lobes obliquely oblong-obovate, 0.4–0.5 cm. long, spreading; stamens inserted about midway within the corolla-tube, the anthers 0.2 cm. long, glabrous or very minutely papillate, broadly auriculate; ovary ovoid, about 0.05 cm. long, glabrous; stigma 0.125 cm. long; nectaries 5, about half as long as the ovary; follicles usually somewhat falcate, conspicuously moniliform, 9–20 cm. long, glabrous or rarely minutely puberulent-papillate; seeds about 1 cm. long, the pale yellowish coma about 2 cm. long.

JAMAICA: rocky hillside, Mandeville to Lincoln, Parish of Manchester, Sept. 3–7, 1908, *Britton 3127* (NY); roadside bank, Mandeville and vicinity, Aug. 29, 1907, *Britton 1008* (NY); Lucea, Jan. 10, 1891, *Rothrock 146* (FM); Blue Mountains, alt. 3750 ft., Dec. 12, 1890, *Rothrock 369* (FM); Keith Hall, alt. 2000 ft., Aug. 30, 1900, *Thompson 7975* (FM, NY); waysides, Cinchona, alt. 5000 ft., July 26, 1903, *Nichols 162* (FM, MBG, US); Lucea, Jan. 3, 1891, *Hitchcock s. n.* (MBG); Constant Spring, Dec. 10, 1890, *Hitchcock s. n.* (MBG); along road, Orange River Valley, near Montego Bay, March 29–30, 1920, *Maxon & Killip 1675* (G, US); Bog Walk, May 4–5, 1910, *Crawford 821* (PA); Blue Mt. Peak, Dec. 13, 1890, *Hitchcock s. n.* (MBG); Bethlehem, St. Elizabeth, Sept. 1901, *Harris 8285* (B); Hope Estate, Nov., 1849, *Alexander s. n.* (K); Halberstadt, Port Royal Mts., alt. 2400 ft., Febr., 1924, *Norman 199* (BM); between Gordon Town and Guara Bridge, Oct. 2, 1901, *Fawcett s. n.* (BM); seacoast, climbing on fences, near Falmouth, Febr. 18, 1893, *Harris 7237* (BM); Long Hill, road to Bethlehem, Santa Cruz Mts., May 7, 1915, *Perkins 276* (B); DATA INCOMPLETE: *Alexander s. n.* (K, NY); *Hart s. n.* (NY); *Purdie s. n.* (K); *Andrews s. n.* (K); *Houston s. n.* (BM); *Cumming 51* (BM); *Swartz s. n.* (S).

MEXICO: YUCATAN: ruins of Uxmal, Sept. 16, 1865, *Schott 673* (BM, FM); Chicxulub, Sept., 1916, *Gaumer 23423* (C, FM, G, MBG, S); common in bushland about Izamal, Aug., year lacking, *Gaumer 883* (BM, C, FM, MBG, S); Chichankanab, date lacking, *Gaumer 2013* (FM, G); DATA INCOMPLETE: 1895, *Gaumer 881* (FM, G, MBG, US).

Although the specimens cited from Jamaica are very stable, and show infrequent and inconsequential variations, the specimens from Yucatan are much less uniform, particularly in regard to the presence of an indument.

10. **Mandevilla Karwinskii** (Muell.-Arg.) Hemsl. Biol. Centr.-Am. Bot. **2**: 316. 1882.

Amblyanthera Karwinskii Muell.-Arg. Linnaea **30**: 426. 1860.

Echites Karwinskii (Muell.-Arg.) Miers, Apoc. So. Am. 206. 1878.

Echites (*Euechites*) *Coulteri* S. Wats. Proc. Am. Acad. **18**: 113. 1883.

Suberect or trailing, suffrutescent herbs, infrequently somewhat twining; stems terete, relatively slender, minutely puberulent when young, becoming glabrate; leaves opposite, shortly petiolate, oblanceolate to narrowly spatulate, apex obtuse to broadly acute, base gradually narrowed and somewhat decurrent, rarely obscurely cordate, 1.5–5.0 cm. long, 0.5–2.0 cm. broad, membranaceous, finely puberulent, particularly beneath, above sparsely glandular at the base of the midrib; petiole 0.2–0.3 cm. long; nodal appendages minute; inflorescence lateral, subcorymbose, simple, about as long as the subtending leaves, bearing 3–7 white or cream-colored flowers; pedicels 0.4–0.6 cm. long; bracts lanceolate, 0.2–0.5 cm. long, scarious; calyx-lobes lanceolate-trigonal, acute to acuminate, 0.3–0.4 cm. long, scarious, glabrous, the squamellae in alternate groups of 4–6; corolla salverform, glabrous without, the tube straight, 0.7–0.9 cm. long, about 0.1 cm. in diameter at the base, the lobes obliquely obovate, 0.7–0.8 cm. long, spreading; stamens inserted about midway within the corolla-tube, the anthers 0.2 cm. long, glabrous, obscurely cordate; ovary oblong-ovoid, about 0.15 cm. long, glabrous; stigma 0.2 cm. long; nectaries 5, compressed-ovoid, about half as long as the ovary; follicles falcate or somewhat divaricate, essentially continuous, glabrous or rarely somewhat puberulent, 6–10 cm. long; seeds about 1 cm. long, the pale yellowish coma about 1.5 cm. long.

Mexico: coahuila: canyons and elevated portion of Sierra Madre, 12–14 leagues south of Saltillo, July 25–Aug. 1, 1880, *E. Palmer 805* (BB, G, K, PA, US); San Lorenzo Canyon, 6 mi. southeast of Saltillo, July 9, 1905, *E. Palmer 697* (FM, G, MBG, NY, US); Saltillo and vicinity, Nov. 2–5, 1898, *E. Palmer 571* (US); Sierra de Parras, Oct., 1910, *Purpus 4613* (B, BM, FM, G, MBG, US); san luis potosi: en route from San Louis Potosi to Tampico, Dec. 1878–Febr. 1879, *E. Palmer 1127* (BM, G, K); Alvarez, May 19–22, 1905, *E. Palmer 605* (FM, G, NY, US); Minas de San Rafael, May, 1911, *Purpus 5213* (FM, MBG, NY, US); hidalgo: near Ixmiquilpan, 1905, *Rose Painter & Rose 9055* (US); same locality, July–Sept., 1905, *Purpus 1392* (G); Sierra de la Mesa, July 21–Aug. 1, 1905, *Rose Painter & Rose 9129* (US); data incomplete: *Coulter 957* (Camb., G, K, NY).

11. **Mandevilla foliosa** (Muell.-Arg.) Hemsl. Biol. Centr.-Am. Bot. **2**: 316. 1882.

Amblyanthera foliosa Muell.-Arg. Linnaea **30**: 427. 1860.

Laseguea foliosa (Muell.-Arg.) Miers, Apoc. So. Am. 253. 1878.

Trachelospermum stans A. Gray, Proc. Am. Acad. **21**: 394. 1886.

Secondatia stans (A. Gray) Standl. Contr. U. S. Nat. Herb. **23**: 1165. 1924.

Erect or ascending, suffrutescent herbs; stems terete, relatively slender, densely puberulent when young, becoming glabrate; leaves opposite, petiolate, ovate-elliptic, apex acute to acuminate, base gradually narrowed and obscurely cordate, 6–15 cm. long, 2–7 cm. broad, membranaceous, above minutely pilose to glabrate, sparsely glandular at the base of the midrib, beneath minutely and generally pilose; petiole 0.5–1.0 cm. long; nodal appendages minute; inflorescence lateral, subcorymbose, simple, usually much shorter than the leaves, bearing 3–12 whitish or cream-colored flowers; pedicels 0.5–1.0 cm. long; bracts lanceolate, 0.3–1.0 cm. long, scarious; calyx-lobes lanceolate-trigonal, acuminate, 0.4–0.6 cm. long, scarious, glabrous; corolla salverform, glabrous without, the tube straight, 1.0–1.5 cm. long, about 0.1 cm. in diameter at the base, the lobes obliquely oblong-obovate, 0.75–1.0 cm. long, spreading; stamens inserted above midway within the corolla-tube, the anthers 0.3 cm. long, glabrous, broadly auriculate; ovary ovoid, about 0.2 cm. long, glabrous; stigma 0.2 cm. long; nectaries 5, somewhat shorter than the ovary; follicles falcate, articulated or somewhat moniliform, 8–12 cm. long, minutely puberulent to glabrate; seeds about 1 cm. long, the pale yellowish coma about 2 cm. long.

MEXICO: CHIHUAHUA: rocky hills near Chihuahua, July 24, 1885, *Pringle 640* (AA, B, Bx, MBG, NY, US); canyons, mountains near Chihuahua, July 24, 1886, *Pringle 701* (B, BM, Bx, MBG, NY, US); SINALOA: La Petaca, Concordia, alt. 1500 m., Dec., 1915, *Delesa 1653* (US); DURANGO: Inde, alt. 2000 m., June, 1927, *Reko 5166* (US); Tobar, May 28–31, 1906, *E. Palmer 238* (G, MBG, NY, US); Santiago Papasquiaro, Apr.–Aug., 1896, *E. Palmer 395* (B, FM, G, MBG, NY, US); Pipasaniaro [?], Aug. 7, 1898, *Nelson 4658* (G, MBG, US); JALISCO: Chapala, Nov. 1886, *E. Palmer 724* (G, US); GUANAJUATO: Montes de Obrajuelo, Oct. 12, 1913, *Salazar s. n.* (US); exact locality lacking, 1880, *Duges s. n.* (G); QUERETARO: Queretaro, alt. 1850 m., 1910–13, *Aguiel 10408* (FM, G, US); rocky hillside, near San Juan del Rio, Aug. 17, 1905, *Rose Painter & Rose 9510* (NY, US); del Cierva a Cadereyta, Aug. 21, 1905, *Altamirano 1639* (US); VERA CRUZ: Wartenburg, near Tantoyuca, Prov. Huasteca, 1858, *Ervendberg 240* (G); MICHOACAN: Coronilla, près Morelia, Sept. 19, 1910, *Arsene s. n.* (FM); Monteleon, lava fields, alt. 5500 ft., Aug. 19, 1902, *Pringle 11015* (B, G, MBG, NY, US); environs de Morelia, Loma del Zapote, alt. 1900 m., July 27, 1909, *Arsène 2668* (B); MEXICO: umgebund de Stadt Mexico, 1920–21,

Reiche s. n. (B); MORELOS: vulkanischer Boden mit Waldresten, alt. 1450 m., Dec. 12, 1905, *Endlich 1075* (B); DATA INCOMPLETE: *Ehrenberg 1369* (B); *Schiede 448, 493* (B).

12. **Mandevilla mexicana** (Muell.-Arg.) Woodson, Ann. Mo. Bot. Gard. **19**: 65. 1932.

Amblyanthera mexicana Muell.-Arg. Linnaea **30**: 424. 1860.

Echites mexicana (Muell.-Arg.) Miers, Apoc. So. Am. 205. 1878.

Echites Smithii Greenm. Proc. Am. Acad. **40**: 29. 1904.

Erect or ascending, suffrutescent herbs; stems terete, relatively slender, minutely puberulent when young, becoming glabrate; leaves opposite, shortly petiolate, ovate-oblong to ovate-lanceolate, apex acute to obtuse, base rather gradually narrowed, obscurely cordate, 2–5 cm. long, 0.5–2.0 cm. broad, membranaceous, above glabrous, sparsely glandular at the base of the midrib, beneath minutely puberulent along the midrib; petiole 1.0–1.5 cm. long; nodal appendages minute; inflorescence lateral, subcorymbose, simple, about half as long as the subtending leaves, bearing 3–7 white or cream-colored flowers; pedicels 0.5–0.75 cm. long; bracts lanceolate, 0.15–0.3 cm. long, scarious; calyx-lobes lanceolate-trigonal, acuminate, 0.4–0.6 cm. long, scarious, glabrous, the squamellae in alternate groups of 4–6; corolla salverform, glabrous without, the tube straight, about 1 cm. long, about 0.1 cm. in diameter at the base, the lobes obliquely obovate, about as long as the tube, spreading; stamens inserted above midway within the corolla-tube, the anthers 0.3 cm. long, glabrous, broadly auriculate; ovary ovoid, about 0.1 cm. long, glabrous; stigma 0.25 cm. long; nectaries 5, about half as long as the ovary; follicles falcate, inconspicuously articulated, 8–10 cm. long, glabrous; seeds about 1 cm. long, the pale tawny coma about 2 cm. long.

MEXICO: MICHOACAN: Zapote, près Morelia, June 27, 1909, *Arsène s. n.* (BM); OAXACA: Saloma, alt. 6500 ft., Aug. 9, 1895, *Smith 672* (G); Huauchilla to Nochixtlan, alt. 2000 ft., June, 1901, *Conzatti & Gonzalez 1198* (B, G); Huachilla, distrito de Nochixtlan, June 19, 1907, *Conzatti 1837* (FM, US); same locality, Oct. 15, 1921, *Conzatti 4277* (US).

13. **Mandevilla apocynifolia** (A. Gray) Woodson, Ann. Mo. Bot. Gard. **19**: 65. 1932.

Echites (*Amblyanthera ?*) *apocynifolia* A. Gray, Proc. Am. Acad. 22: 435. 1887.

Erect or ascending, suffrutescent herbs; stems terete, relatively slender, minutely puberulent when young, becoming glabrate; leaves opposite, shortly petiolate, ovate-oblong to ovate-lanceolate, apex acute to acuminate, base rather abruptly and obscurely cordate, 4–7 cm. long, 1.5–2.0 cm. broad, membranaceous, above glabrous, sparsely glandular at the base of the midrib, above minutely puberulent, particularly along the veins; petiole 0.2–0.3 cm. long; nodal appendages minute; inflorescence lateral, simply racemose, somewhat surpassing the subtending leaves, bearing 3–10 white or pale cream-colored flowers; pedicels 1.0–1.25 cm. long; bracts lanceolate, 0.2–0.4 cm. long; calyx-lobes lanceolate-trigonal, acuminate, 0.4–0.5 cm. long, scarious, glabrous, the squamellae indefinitely distributed; corolla salverform, glabrous without, the tube straight, 1.0–1.25 cm. long, about 0.15 cm. in diameter at the base, the lobes obliquely obovate, about as long as the tube, spreading; stamens inserted about midway within the corolla-tube, the anthers 0.3 cm. long, broadly cordate; ovary ovoid, about 0.15 cm. long, minutely papillate; stigma 0.15 cm. long; nectaries 5, about as long as the ovary; follicles falcate, articulated, 6–9 cm. long, minutely puberulent to glabrate; seeds 0.75 cm. long, the pale yellowish coma about 1.5 cm. long.

MEXICO: JALISCO: Rio Blanco, July, 1886, *E. Palmer 734* (G, TYPE, MBG, photograph and analytical drawings); Rio Blanco, near Guadalajara, July 22, 1902, *Pringle 11357* (G).

Sect. 3. MONTANAE Woodson. Corolla salverform or tubular-salverform; nectaries 2–5, shorter than the ovary, or obsolete; anthers narrowly oblong to oblong-lanceolate, truncate or merely somewhat emarginate or concave at the base, not definitely auriculate; lianas (erect or ascending, suffrutescent herbs in *M. erecta* and *M. pycnantha*) of South America. *Spp. 14–29.*

KEY TO THE SPECIES

a. Nectaries 5.
  b. Corolla strictly salverform, the limb conspicuous and definitely reflexed or spreading.
    c. Lianas; inflorescence lateral.
      d. Squamellae in groups of several, alternate with the calyx-lobes or indefinitely distributed.

e. Leaves definitely petiolate; calyx-lobes lanceolate to ovate-lanceolate.
f. Limb ¼ to ½ as long as the corolla-tube.
g. Corolla-tube about 1 cm. long, about twice as long as the limb .... *14. M. scutifolia*
gg. Corolla-tube 1.5–2.5 cm. long, 3–4 times as long as the limb.
h. Plants glabrous or irregularly and minutely puberulent to glabrate; leaves obtuse to rounded at the base, not cordate; limb about ¼ as long as the corolla-tube .... *15. M. callacatensis*
hh. Plants puberulent to hirtellous, rarely glabrate; leaves cordate; limb about ⅓ as long as the corolla-tube .... *16. M. montana*
ff. Limb more than ½ as long as the corolla-tube.
g. Limb about ⅔ as long as the tube; leaves ovate-lanceolate to ovate-oblong .... *17. M. riparia*
gg. Limb as long as the tube or somewhat longer; leaves ovate to ovate-oblong .... *18. M. Jamesonii*
ee. Leaves sessile and amplexicaul; calyx-lobes ovate-subreniform .... *19. M. subsessilis*
dd. Squamellae solitary and alternate with the calyx-lobes .... *20. M. fragilis*
cc. Erect or ascending, suffrutescent herbs or suffruticose undershrubs; inflorescence both terminal and lateral .... *21. M. pycnantha*
bb. Corolla tubular-salverform, the limb relatively inconspicuous, erect or essentially so.
c. Calyx-lobes much shorter than the corolla-tube.
d. Corolla glabrous without, not becoming black when desiccated; leaves obtuse or rounded at the base, not cordate.. *22. M. cercophylla*
dd. Corolla densely glandular-papillate without, becoming black when desiccated; leaves strongly cordate.............. *23. M. brachyloba*
cc. Calyx-lobes about as long as the corolla-tube or somewhat longer.
d. Lianas; leaves distinctly petiolate................. *24. M. Pentlandiana*
dd. Erect or ascending suffrutescent herbs, or low suffrutescent undershrubs; leaves shortly petiolate to subsessile............ *25. M. erecta*
aa. Nectaries fewer than 5, rarely obsolete.
b. Corolla-lobes obliquely oblong-elliptic; bracts conspicuous, subfoliaceous; leaves sparsely glandular along the midrib above; nectaries evident .... *26. M. congesta*
bb. Corolla-lobes broadly obovate; bracts inconspicuous, scarious; leaves glandular at the base of the midrib above; nectaries obsolete or extremely inconspicuous.
c. Corolla-tube longer than the limb.................... *27. M. Achrestogyne*
cc. Corolla-tube about as long as, or shorter than, the limb.
d. Leaves oblong- to obovate-elliptic, 5–9 cm. long; corolla glabrous without, the tube about 0.75 cm. long............ *28. M. bogotensis*
dd. Leaves ovate to broadly ovate-oblong, 15–20 cm. long; corolla densely puberulent-papillate without, the tube about 1.25 cm. long.................................... *29. M. subpaniculata*

14. Mandevilla scutifolia Woodson, Ann. Mo. Bot. Gard. 19: 57. 1932.

Suffruticose lianas; stems terete, relatively slender, puberulent to glabrate; leaves opposite, petiolate, ovate to ovate-oblong, apex abruptly acute to acuminate, base abruptly and obscurely cordate, 2–5 cm. long, 1.5–3.0 cm. broad, membranaceous, above minutely and irregularly puberulent, glandular at the base of the midrib, beneath barbate in the axils of the midrib; petiole 1.0–1.25 cm. long; nodal appendages minute; inflorescence lateral, simply racemose, equalling or slightly surpassing the subtending leaves, bearing 3–10 yellowish flowers clustered near the end of a naked peduncle; pedicels 0.75–1.0 cm. long; bracts ovate-lanceolate, 0.2–0.3 cm. long, scarious; calyx-lobes ovate-lanceolate, acute to acuminate, 0.3–0.35 cm. long, scarious, minutely and densely puberulent, the squamellae in alternate groups of 3–4; corolla salverform, glabrous without, the tube straight, 1.0–1.25 cm. long, about 0.15 cm. in diameter at the base, the lobes obliquely obovate, 0.5–0.6 cm. long, widely spreading; stamens inserted about midway within the corolla-tube, the anthers 0.4 cm. long, truncate; ovary oblong-ovoid, about 0.1 cm. long, glabrous; stigma 0.3 cm. long; nectaries 5, compressed-ovoid, about half as long as the ovary; follicles unknown.

PERU: "Andes of Saragosa," date lacking, *Lobb s. n.* (K, TYPE, MBG, photograph and analytical drawings).

15. Mandevilla callacatensis Mgf. Notizblatt 9: 83. 1924.

Suffruticose lianas; stems terete, relatively slender, minutely puberulent-papillate to glabrate; leaves opposite, petiolate, broadly ovate- to oblong-elliptic, apex acute to abruptly acuminate, base obtuse or rounded, not cordate, 2.5–6.0 cm. long, 1.5–4.0 cm. broad, membranaceous, either surface minutely puberulent-papillate to glabrate, above sparsely glandular at the base of the midrib; petiole 1–2 cm. long; nodal appendages inconspicuous; inflorescence lateral, simply racemose, somewhat longer than the subtending leaves, bearing 5–12 yellowish flowers; pedicels 1.0–1.25 cm. long; bracts oblong-lanceolate, 0.15–0.2 cm. long; calyx-lobes lanceolate, acuminate, 0.2–0.3 cm. long, granulo-puberulent, the squamellae indefinitely distributed; corolla salverform, gla-

brous without, the tube straight, 2.0–2.5 cm. long, about 0.15 cm. in diameter at the base, the lobes obliquely ovate, 0.5 cm. long, reflexed or widely spreading; stamens inserted near the orifice of the corolla-tube, the anthers 0.5 cm. long, truncate; ovary oblong-ovoid, about 0.15 cm. long; stigma 0.25–0.3 cm. long; nectaries 5, compressed-ovoid, about half as long as the ovary; follicles essentially continuous, about 30 cm. long, glabrous; seeds about 0.75 cm. long, the brilliant tawny coma about 1.5 cm. long.

PERU: CAJAMARCA: Tal des Rio Chotano bei Callacate, zwischen Querocotillo und Cutervo, alt. 1400 m., June 1, 1915, *Weberbauer 7128* (B, TYPE, FM, MBG, photograph and analytical drawings); Callacate, May, 1879, *Jelski 375* (B, V).

16. **Mandevilla montana** (HBK.) Mgf. Notizblatt **9**: 82. 1924.

Echites montana HBK. Nov. Gen. **3**: 213. 1819; A. DC. in DC. Prodr. **8**: 465. 1844; Miers, Apoc. So. Am. 199. 1878.

Suffruticose lianas; stems terete, relatively slender, densely puberulent to glabrate; leaves opposite, petiolate, ovate to ovate-oblong, apex acute to acuminate, base rather abruptly and broadly cordate, 3–9 cm. long, 1.5–5.0 cm. broad, membranaceous, above minutely hirtellous to glabrate, glandular at the base of the midrib, beneath minutely puberulent to tomentulose, particularly along the veins; petiole 0.75–3.0 cm. long; nodal appendages inconspicuous; inflorescence lateral, simply racemose, usually somewhat shorter than the subtending leaves, bearing 5–8 yellowish flowers; pedicels 0.5–1.0 cm. long; bracts lanceolate, 0.3–0.5 cm. long, scarious; calyx-lobes lanceolate, acuminate, 0.3–0.5 cm. long, scarious, minutely puberulent, the squamellae indefinitely distributed; corolla salverform, glabrous without, the tube straight, 1.75–2.0 cm. long, about 0.1 cm. in diameter at the base, the lobes obliquely obovate, 0.5–0.75 cm. long, spreading; stamens inserted near the orifice of the corolla-tube, the anthers 0.4–0.5 cm. long, truncate; ovary oblong-ovoid, about 0.15 cm. long, glabrous; stigma 0.3 cm. long; nectaries 5, compressed-oblongoid, about half as long as the ovary; follicles unknown.

COLOMBIA: CAUCA: Popayan, alt. 1600–2000 m., Jan.–March, year lacking, *Lehmann 4801* (FM, G, K, S, US); lacis alsis Andium Pastoensium in convallii fl. Guay-

tana, alt. 850 m., Dec., year lacking, *Humboldt & Bonpland s. n.* (B, TYPE); TOLIMA: forest, Azufral to Moral, Old Quindio trail, alt. 1800–2300 m., Aug. 3, 1922, *Killip & Hazen 9605* (NY).

17. **Mandevilla riparia** (HBK.) Woodson, Ann. Mo. Bot. Gard. 19: 58. 1932.

Echites riparia HBK. Nov. Gen. 3: 214. 1819; A. DC. in DC. Prodr. 8: 466. 1844; Miers, Apoc. So. Am. 199. 1878.

Amblyanthera andina Muell.-Arg. Linnaea 30: 425. 1860.

Echites andina (Muell.-Arg.) Miers, loc. cit. 204. 1878.

Echites assimilis K. Sch. in Engl. Bot. Jahrb. 25: 724. 1898.

Mandevilla montana (HBK.) Mgf. var. *peruviana* Mgf. Notizblatt 9: 82. 1924.

Suffruticose lianas; stems terete, relatively slender, finely puberulent to glabrate; leaves opposite, petiolate, ovate-lanceolate to ovate-oblong, apex acute to acuminate, base abruptly and rather broadly cordate, 4–9 cm. long, 1.5–4.0 cm. broad, membranaceous, above minutely and densely puberulent to glabrate, glandular at the base of the midrib, beneath generally puberulent to barbate in the axils of the midrib; petiole 0.75–2.0 cm. long; nodal appendages inconspicuous; inflorescence lateral, simply racemose, about as long as the subtending leaves, bearing 8–12 yellowish, reddish-tinged flowers; pedicels 0.5–1.0 cm. long; bracts lanceolate, 0.2 cm. long, scarious; calyx-lobes lanceolate, acuminate, 0.5–0.7 cm. long, scarious, minutely puberulent, the squamellae indefinitely distributed; corolla salverform, glabrous or minutely papillate without, the tube straight, 1.25–1.5 cm. long, about 0.15 cm. in diameter at the base, the lobes obliquely obovate-oblong, 1.0–1.25 cm. long, widely spreading; stamens inserted near the orifice of the corolla-tube, the anthers 0.5–0.6 cm. long, truncate; ovary oblong-ovoid, about 0.15 cm. long, glabrous; stigma 0.4–0.5 cm. long; nectaries 5, compressed-obovoid, about half as long as the ovary; follicles unknown.

ECUADOR: IMBABURA: Cotacachi, ad marg. viae ad Peribrucha, Aug. 30, 1920, *Holmgren 920* (S); PICHINCHA: camino de Ciuapulo a Ciumbaja, alt. 2650 m., Nov., 1927, *Firmin 241* (FM, MBG, US); in coll. interam. ca. Quito, June, 1872, *Sodiro 10616* (B); Quito, Panecillo, 1892, *Lagerheim s. n.* (S); camino de la Magdalena a Chilibula, alt. 2800 m., Sept. 28, 1928, *Firmin 608* (FM, MBG, US); Quito, date lacking, *Karsten s. n.* (V); Quitensian Andes, 1855, *Couthouy s. n.* (G, NY); near

Quito, alt. 2000 m., Nov. 20, 1880, *Lehmann 439* (BB, K); in silv. prope Quitaga, Febr., 1874, *Sodiro 10613* (B); Quitensian Andes, date lacking, *Jameson 101* (BB, BM, DL, K, V); Tambillo, Aug. 13, 1878, *Jelski 336* (B).

Peru: cajamarca: Tal des Rio de Socota, Cutervo, June 6, 1915, *Weberbauer 7131* (B).

The type specimen of this species, cited by Kunth as having been collected in the neighborhood of Tenerife, Dept. Magdalena, Colombia, has not been available for examination during these studies. The plants referred to this species in the paragraphs immediately preceding coincide closely with the original description of *Echites riparia* HBK., however, and it is believed that there they may be assigned with a fair degree of certainty.

18. **Mandevilla Jamesonii** Woodson, Ann. Mo. Bot. Gard. 19: 58. 1932.

Suffruticose lianas; stems terete, relatively slender, finely puberulent to glabrate; leaves opposite, petiolate, ovate to ovate-oblong, apex acute to acuminate, base rather abruptly and obscurely cordate, 3–6 cm. long, 2–4 cm. broad, membranaceous, above puberulent or subhirtellous to glabrate, glandular at the base of the midrib, beneath softly puberulent; petiole 0.75–1.0 cm. long; nodal appendages inconspicuous; inflorescence lateral or subterminal, simply racemose, about as long as the subtending leaves, bearing 5–7 yellowish flowers; pedicels 1.0–1.25 cm. long; bracts narrowly lanceolate, 0.2–0.3 cm. long, scarious; calyx-lobes lanceolate, acuminate, 0.4–0.5 cm. long, scarious, finely puberulent, the squamellae in alternate groups of 4–5; corolla salverform, glabrous or very minutely papillate without, the tube straight, 2 cm. long, about 0.15 cm. in diameter at the base, the lobes obliquely obovate-dolabriform, round at the apex, about as long as the tube, widely spreading; stamens inserted at about the middle of the corolla-tube, the anthers 0.5–0.6 cm. long, truncate at the base or occasionally slightly concave; ovary oblong-ovoid, about 0.1 cm. long, glabrous; stigma 0.5 cm. long; nectaries 5, compressed-obovoid, about half as long as the ovary; follicles unknown.

Ecuador: loja: hedges, Loxa, date lacking, *Jameson 153* (K, type, MBG, photograph and analytical drawings).

19. Mandevilla subsessilis (A. DC.) Woodson, Ann. Mo. Bot. Gard. **19**: 59. 1932.

Echites subsessilis A. DC. in DC. Prodr. **8**: 451. 1844; Miers, Apoc. So. Am. 199. 1878.

Suffruticose lianas; stems terete, relatively stout, glabrous or essentially so; leaves opposite, sessile or subsessile, broadly ovate to orbicular-ovate, apex obtuse to very abruptly acuminate, base conspicuously cordate and amplexicaul, 10–12 cm. long, 6–7 cm. broad in our depauperate specimen, firmly membranaceous, above minutely hispidulous to glabrate, glandular at the base of the midrib, beneath softly puberulent, particularly along the veins; nodal appendages inconspicuous; inflorescence lateral, simply racemose, somewhat surpassing the subtending leaves, bearing about 15 pale, yellowish flowers; pedicels 1 cm. long; bracts lanceolate, acuminate, 0.5 cm. long, scarious; calyx-lobes ovate-subreniform, obtuse to rounded, 0.5–0.55 cm. long, scarious, glabrous, the squamellae in alternate groups of 4–5; corolla salverform, glabrous without, the tube straight, 2 cm. long, about 0.15 cm. in diameter at the base, the lobes obliquely obovate-dolabriform, about as long as the tube, widely spreading; stamens inserted near the orifice of the corolla-tube, the anthers 0.5 cm. long, truncate or slightly concave at the base; ovary ovoid, about 0.15 cm. long, glabrous; stigma 0.4 cm. long; nectaries 5, compressed obovoid, about half as long as the ovary; follicles unknown.

PERU: "Mexico ? Peruvia ?," exact locality and date lacking, *Pavon s. n.* (BB, TYPE, MBG, photograph and analytical drawings).

Although the label indicates the type specimen of this species as of doubtful origin, the reproductive morphology indicates an indubitable affinity with the species of northern South America, and not of Mexico and Central America.

20. Mandevilla fragilis Woodson, Ann. Mo. Bot. Gard. **19**: 59. 1932.

Suffrutescent lianas; stems terete, relatively slender, minutely and sparsely puberulent when very young, soon becoming glabrate; leaves opposite, petiolate, narrowly oblong-lanceolate, apex acuminate, base obscurely cordate, 5–7 cm. long, 0.75–1.5

cm. broad, delicately membranaceous, above glabrous, very sparsely glandular at the base of the midrib, beneath inconspicuously barbate in the axils of the midrib; petiole 0.75–1.25 cm. long; nodal appendages very inconspicuous; inflorescence lateral, simply racemose, somewhat shorter than the subtending leaves, bearing 3–5 reddish flowers; pedicels 0.75–1.0 cm. long; bracts very minute, scarious; calyx-lobes ovate, acute, 0.075–0.1 cm. long, glabrous, the alternate squamellae solitary; corolla salverform, glabrous without, the tube 1.25 cm. long, about 0.15 cm. in diameter at the base, the lobes obliquely obovate-oblong, 0.75–1.0 cm. long, widely spreading; stamens inserted about midway within the corolla-tube, the anthers 0.3 cm. long, truncate; ovary oblong-ovoid, about 0.1 cm. long, glabrous; stigma 0.3 cm. long; nectaries 5, ovoid, about half as long as the ovary; follicles unknown.

BOLIVIA: exact locality and date lacking, *Bang 2271* (K, TYPE, NY, MBG, photograph and analytical drawings).

21. **Mandevilla pycnantha** (Steud.) Woodson, Ann. Mo. Bot. Gard. **19**: 60. 1932.

Echites densiflora Pohl, ex Stadelm. Flora **24**[1]: Beibl. 56. 1841, not Blume.

Echites pycnantha Steud. Nomencl. ed. 2. **1**: 540. 1841, nom. nud. in synon.

Echites pycnantha Steud. ex A. DC. in DC. Prodr. **8**: 469. 1844; Benth. & Hook. Gen. Pl. **2**: 724. 1876.

Heterothrix pycnantha (Steud.) Muell.-Arg. in Mart. Fl. Bras. **6**[1]: 133. *pl. 40.* 1860; Miers, Apoc. So. Am. 264. 1878.

Echites pycnanthe (Müll.-Arg.) Benth. & Hook. ex K. Sch. in Engl. & Prantl, Nat. Pflanzenfam. **4**[2]: 166. 1895, sphalm.

Erect or ascending suffrutescent herbs, or low, suffruticose undershrubs; stems terete, relatively stout, hirtellous to glabrate; leaves opposite, very shortly petiolate to subsessile, broadly ovate to ovate-oblong, apex broadly obtuse to rounded, base broadly and obscurely cordate, 4–12 cm. long, 3.5–8.0 cm. broad, firmly membranaceous to subcoriaceous, above densely puberulent to

hirtellous, glandular at the base of the midrib, beneath finely tomentulose; petiole about 0.5 cm. long or somewhat less; nodal appendages inconspicuous; inflorescence both terminal and lateral, simply racemose, somewhat shorter than the subtending leaves, bearing 15–35 greenish-yellow or roseate flowers; pedicels 0.75 cm. long; bracts lanceolate, acute to acuminate, about 0.5 cm. long, scarious; calyx-lobes oblong-lanceolate, acute to acuminate, 0.4 cm. long, scarious, minutely puberulent-papillate, the squamellae in alternate groups of 4–5; corolla salverform, glabrous without, the tube straight, 0.75 cm. long, about 0.1 cm. in diameter at the base, the lobes obliquely oblong-obovate, about as long as the tube, spreading; stamens inserted about midway within the corolla-tube, the anthers 0.5 cm. long, slightly concave at the base; ovary oblong-ovoid, about 0.15 cm. long, glabrous; stigma 0.3 cm. long; nectaries 5, compressed-obovoid, about half as long as the ovary; follicles falcate, rather obscurely articulated, 7–10 cm. long, glabrous; seeds 0.7 cm. long, the brilliant tawny coma about 1.25 cm. long.

BRAZIL: MINAS GERAES: Serra do Pinheiro, date lacking, *Pohl s. n.* (Bx, MBG, photograph and analytical drawings); Serra da Lapa, date lacking, *Riedel 985* (Bx, TYPE, G, K, V, MBG, photograph and analytical drawings).

As has already been explained (Ann. Mo. Bot. Gard. **19**: 60. 1932), an examination of the only fruiting specimen of this species (*Pohl s. n.*) fails to demonstrate the complex seminal coma ascribed to it by Mueller-Argoviensis in founding the genus *Heterothrix*. Accordingly it has been transferred to *Mandevilla*, as the structure of the flowers, inflorescence, and foliar glands warrant.

22. **Mandevilla cercophylla** Woodson, Ann. Mo. Bot. Gard. **19**: 61. 1932.

Suffruticose lianas; stems terete, relatively slender, glabrous; leaves opposite, petiolate, obovate-oblong, apex acuminate-subcaudate, base somewhat cuneate, obtuse or rounded, not cordate, 3–6 cm. long, 1–3 cm. broad, subcoriaceous, glabrous throughout, glandular at the base of the midrib above; petiole 0.5 cm. long; nodal appendages inconspicuous; inflorescence lateral, simply racemose, the conspicuously flexuose peduncle

somewhat shorter than the subtending leaves, bearing 8–17 rather distant, greenish-yellow or roseate flowers; pedicels 0.75–1.0 cm. long; bracts very inconspicuous, scarious; calyx-lobes ovate-trigonal, acute, 0.1 cm. long, scarious, glabrous, the squamellae indefinitely distributed; corolla tubular-salverform, glabrous without, the tube straight, 1.25 cm. long, about 0.1 cm. in diameter at the base, the lobes obliquely ovate, 0.5 cm. long, erect or essentially so; stamens inserted near the orifice of the corolla-tube, the anthers 0.45 cm. long, truncate; ovary oblong-ovoid, about 0.15 cm. long, glabrous; stigma 0.3 cm. long; nectaries 5, oblong-ovoid, compressed, about half as long as the ovary; immature follicles somewhat falcate, very obscurely articulated, 12–15 cm. long, glabrous.

PERU: HUANUCO: Casapi, date lacking, *Matthews 1978* (K, Camb., TYPE, MBG, photograph and analytical drawings).

23. **Mandevilla brachyloba** (Muell.-Arg.) K. Sch. in Engl. & Prantl, Nat. Pflanzenfam. 4²: 171. 1895.

Amblyanthera brachyloba Muell.-Arg. Linnaea **30**: 423. 1860.

Echites brachyloba (Muell.-Arg.) Miers, Apoc. So. Am. 203. 1878.

Suffruticose lianas; stems terete, relatively slender, finely and densely puberulent to glabrate; leaves opposite, petiolate, ovate to ovate-oblong, apex rather abruptly acuminate, base abruptly and broadly cordate, 4–12 cm. long, 2–6 cm. broad, membranaceous, above minutely puberulent to glabrate, glandular at the base of the midrib, beneath generally puberulent to barbate in the axils of the midrib, infrequently glabrate; petiole 1.25–4.0 cm. long; nodal appendages minute; inflorescence lateral, simply racemose, somewhat surpassing the subtending leaves, bearing 15–40 reddish flowers; pedicels 0.75–1.0 cm. long; bracts lanceolate, 0.15–0.3 cm. long, scarious; calyx-lobes ovate-trigonal, acute, 0.2–0.25 cm. long, scarious, densely puberulent-papillate, the squamellae indefinitely distributed; corolla tubular-salverform, densely glandular-papillate without (becoming black when desiccated), the tube straight, 1.5–1.75 cm. long, about 0.15 cm. in diameter at the base, the lobes obliquely ovate, 0.2–0.3 cm. long, erect or essentially so; stamens inserted near the orifice of

the corolla-tube, the anthers 0.4 cm. long, obscurely concave at the base; ovary oblong-ovoid, about 0.15 cm. long, glabrous; stigma 0.15 cm. long; nectaries 5, compressed-obovoid, about half as long as the ovary; follicles somewhat falcate, continuous or very inconspicuously articulated, 20–30 cm. long, glabrous; seeds 1.25 cm. long, the pale tawny coma about 2 cm. long.

PERU: ANCACHS: quebrada of Pariahuanca, date lacking, *Matthews 820* (K); HUANCAVELICA: rechte Talwand des Flüsses Montaro, unter Surcobamba, alt. 1900–2000 m., March 15, 1913, *Weberbauer 6498* (B, FM, US); PUNO: Sandia, alt. 2100–2300 m., May 15, 1902, *Weberbauer 536* (B).

BOLIVIA: LA PAZ: Coroico, alt. 6000–7000 ft., Febr., 1866, *Pearce s. n.* (K); Millu-huaya, alt. 1300 m., Dec., 1917, *Buchtien 609* (B, BM, C, G, K, MBG, NY, S, US); Hacienda Simaco, sobre el camino a Tipuani, alt. 1400 m., Jan., 1920, *Buchtien 5099* (US); Sirupaya, vecinidad de Yanacachi, alt. 2100 m., Nov. 14, 1906, *Buchtien 277* (FM, US); Mapiri, alt. 2500 ft., May, 1886, *Rusby 2585* (B, BB, G, MBG, NY, US, V); Apolo, alt. 4800 ft., Febr. 23, 1902, *Williams 81* (BM, K, NY, US); Yungas, 1890, *Bang 461* (B, BB, C, K, MBG, US); Hacienda Casane, sobre el camino a Tipuani, alt. 1400 m., April 13, 1923, *Buchtien 7439* (C); COCHABAMBA: Waldrand, Socotal, Prov. Chapare, alt. 1500 m., Febr. 8, 1929, *Steinbach 9090* (FM, S).

ARGENTINA: JUJUY: Quinta prope Laguna de la Brea, in marg. silv., June 6, 1901, *Fries 127* (S).

24. **Mandevilla Pentlandiana** (A. DC.) Woodson, Ann. Mo. Bot. Gard. **19**: 63. 1932.

Parsonsia ? bracteata (Hook. & Arn.) in Hook. Jour. Bot. **1**: 287. 1834; A. DC. in DC. Prodr. **8**: 402. 1844.

Laseguea Pentlandiana A. DC. Ann. Sci. Nat. Bot. III. **1**: 262. 1844; Miers, Apoc. So. Am. 253. 1878.

Laseguea Hookeri Muell.-Arg. in Mart. Fl. Bras. **6**^{1}: 136. 1860; Miers, loc. cit. 1878.

Laseguea bracteata (Hook. & Arn.) K. Sch. in Engl. & Prantl, Nat. Pflanzenfam. **4**^{2}: 171. 1895.

Laseguea Mandoni Britton, ex Rusby, Mem. Torrey Bot. Club **4**: 220. 1895.

Suffruticose lianas; stems relatively stout, terete, densely puberulent or hirtellous to glabrate; leaves opposite, petiolate, broadly ovate, apex acutely acuminate, base rather abruptly and broadly cordate, 6–14 cm. long, 4–10 cm. broad, membranaceous, above densely puberulent to glabrate, glandular at the base of the midrib, beneath densely tomentulose to glabrate; petiole 1.5–4.0 cm. long; nodal appendages minute; inflorescence lateral

or rarely subterminal, simply racemose, about twice as long as the subtending leaves, bearing 15–40 greenish-white or cream-colored flowers congested toward the upper half of the peduncle; pedicels 0.25–0.75 cm. long; bracts narrowly oblong-lanceolate, 0.75–2.0 cm. long, subfoliaceous or petaloid; calyx-lobes narrowly oblong-lanceolate, acute to acuminate, 1.0–1.5 cm. long, subfoliaceous or somewhat petaloid, glabrous or minutely papillate, the squamellae indefinitely distributed; corolla tubular-salverform, densely papillate without, the tube straight, 0.75–1.25 cm. long, about 0.1 cm. in diameter at the base, the lobes obliquely ovate, 0.2–0.3 cm. long, erect or essentially so; stamens inserted somewhat above midway within the corolla-tube, the anthers 0.5–0.525 cm. long, truncate or merely somewhat concave at the base; ovary oblong-ovoid, about 0.15 cm. long, glabrous; stigma 0.3–0.35 cm. long; nectaries 5, compressed-obovoid, about half as long as the ovary; follicles somewhat falcate, continuous, puberulent-papillate to glabrate, 15–20 cm. long; seeds 0.5–0.75 cm. long, the pale tawny coma about 1.5 cm. long.

Bolivia: terr. nac. de colonias: cotaña am Illimani, alt. 2450 m., Nov., 1911, *Buchtien 250* (FM, G, MBG, NY, US); Camacho, alt. 2500 m., Dec. 15, 1903, *Fiebrig 2580* (AA); la paz: Milluhuaya, alt. 1300 m., Dec., 1917, *Buchtien 4671* (G, US); Yungas, 1890, *Bang 402* (FM, G, MBG, NY, US); cochabamba: Tunari, May 4, 1892, *Kuntze s. n.* (FM, NY).

Argentina: jujuy: exact locality lacking, Oct., 1892, *Kuntze s. n.* (NY); tucuman: Alto de Medina, Jan. 11, 1924, *Venturi 2738* (BA, MBG); Cerro del Campo, Febr. 12, 1930, *Venturi 10180* (AA); Alambradas, Dept. Capital, alt. 450 m., Jan., 1919, *Venturi 178* (MBG); Villa Naugues, Famailla, alt. 1100 m., Jan., 1926, *Venturi 4076* (MBG); catamarca: Andalgala, Dec. 29, 1916, *Jørgensen 1605* (G, MBG, US); cordoba: exact locality lacking, Dec., 1891, *Kuntze s. n.* (FM, NY).

For notes on this species reference is made to Ann. Mo. Bot. Gard. **19**: 64. 1932.

25. **Mandevilla erecta** (Vell.) Woodson, Ann. Mo. Bot. Gard. **19**: 62. 1932.

Echites erecta Vell. Fl. Flum. 113. 1830; Icon. **3**: *pl. 45.* 1827.

Echites emarginata Vell. loc. cit. *pl. 46.* 1827.

Laseguea Guilleminiana A. DC. in DC. Prodr. **8**: 481. 1844; *ibid.* Ann. Sci. Nat. Bot. III. **1**: 261. 1844; Miers, Apoc. So. Am. 249. 1878.

Laseguea emarginata (Vell.) A. DC. in DC. Prodr. 8: 481. 1844; *ibid.* Ann. Sci. Nat. Bot. III. 1: 261. 1844; Muell.-Arg. in Mart. Fl. Bras. 6^1: 136. 1860; Miers, Apoc. So. Am. 250. 1878.

Laseguea obliquinervia A. DC. Ann. Sci. Nat. Bot. III. 1: 261. 1844; Miers, loc. cit. 250. 1878.

Laseguea acutifolia A. DC. loc. cit. 1844; Arech. Ann. Mus. Nac. Montevideo 7: 73. 1910.

Laseguea glabra A. DC. loc. cit. 262. 1844; Miers, loc. cit 1878.

Laseguea erecta (Vell.) Muell.-Arg. loc. cit. 135. 1860; Miers, loc. cit. 249. 1878.

Laseguea erecta (Vell.) Muell.-Arg. α. *Guilleminiana* (A. DC.) Muell.-Arg. loc. cit. *pl. 41.* 1860.

Laseguea erecta (Vell.) Muell.-Arg. α. *Guilleminiana* (A. DC.) Muell.-Arg. *1. griseo-olivacea* Muell.-Arg. loc. cit. 1860.

Echites bracteata Mart. ex Muell.-Arg. loc. cit. 1860, not Vell., nor HBK., nom. nud. in synon.

Laseguea erecta (Vell.) Muell.-Arg. α. *Guilleminiana* (A. DC.) Muell.-Arg. *2. griseo-fusca* Muell.-Arg. loc. cit. 1860.

Laseguea erecta (Vell.) Muell.-Arg. β. *obliquinervia* (A. DC.) Muell.-Arg. loc. cit. 1860.

Laseguea erecta (Vell.) Muell.-Arg. β. *obliquinervia* (A. DC.) Muell.-Arg. αα. *ovata* Muell.-Arg. loc. cit. 1860.

Laseguea erecta (Vell.) Muell.-Arg. β. *obliquinervia* (A. DC.) Muell.-Arg. αα. *ovata* Muell.-Arg. *1. griseo-olivacea* Muell.-Arg. loc. cit. 1860.

Laseguea erecta (Vell.) Muell.-Arg. β. *obliquinervia* (A. DC.) Muell.-Arg. ββ. *obovata* Muell.-Arg. loc. cit. 1860.

Laseguea erecta (Vell.) Muell.-Arg. γ. *glabrescens* Muell.-Arg. loc. cit. 1860.

Laseguea erecta (Vell.) Muell.-Arg. δ. *acutifolia* (A. DC.) Muell.-Arg. loc. cit. 1860.

Laseguea erecta (Vell.) Muell.-Arg. ε. *scabrinervia* Muell.-Arg. loc. cit. 136. 1860.

Laseguea erecta (Vell.) Muell.-Arg. ζ. *glabra* (A. DC.) Muell.-Arg. loc. cit. 1860.

Laseguea acutifolia A. DC. forma α. *Guilleminiana* (A. DC.) Muell.-Arg. ex Arech. loc. cit. 72. 1910, sphalm.

Laseguea acutifolia A. DC. forma α. *Guilleminiana* (A. DC.) Muell.-Arg. *1. Griseo-olivacea* (Muell.-Arg.) Arech. loc. cit. 1910.

Laseguea acutifolia A. DC. forma α. *Guilleminiana* (A. DC.) Muell.-Arg. *2. Griseo-fusca* (Muell.-Arg.) Arech. loc. cit. 1910.

Laseguea acutifolia A. DC. forma β. *obliquinervia* (A. DC.) Muell.-Arg. ex Arech. loc. cit. 1910, sphalm.

Laseguea acutifolia A. DC. forma β. *obliquinervia* (A. DC.) Muell.-Arg. *αα. ovata* (Muell.-Arg.) Arech. loc. cit. 73. 1910.

Laseguea acutifolia A. DC. forma β. *obliquinervia* (A. DC.) Muell.-Arg. *αα. ovata* (Muell.-Arg.) Arech. *1. griseo olivacea* (Muell.-Arg.) Arech. loc. cit. 1910.

Laseguea acutifolia A. DC. forma β. *obliquinervia* (A. DC.) Muell.-Arg. ββ. *obovata* (Muell.-Arg.) Arech. loc. cit. 1910.

Laseguea acutifolia A. DC. forma γ. *Glabrescens* Muell.-Arg. ex Arech. loc. cit. 1910, sphalm.

Laseguea acutifolia A. DC. forma δ. *scabrinervis* Muell.-Arg. ex Arech. loc. cit. 1910, sphalm.

Laseguea acutifolia A. DC. forma ε. *glabra* (A. DC.) Muell.-Arg. ex Arech. loc. cit. 1910, sphalm.

Erect or ascending, suffrutescent herbs, or low, suffrutescent undershrubs; stems terete, relatively stout, densely puberulent or hirtellous to glabrate; leaves opposite, very shortly petiolate or subsessile, broadly ovate to orbicular-ovate, apex very abruptly acuminate to obtuse or rounded, occasionally somewhat retuse or emarginate, base rather abruptly and broadly cordate, 4–10 cm. long, 2–7 cm. broad, membranaceous, above densely puberulent or hirtellous to glabrate, glandular at the base of the midrib, beneath densely tomentulose (to glabrate or rarely glabrous ?); petiole 0.2–0.5 cm. long; nodal appendages obsolete; inflorescence terminal or subterminal, simply racemose, about twice as long as the subtending leaves, bearing 10–30 congested, greenish-white or yellowish flowers along the peduncle; pedicels 0.25–0.5 cm. long; bracts narrowly oblong-lanceolate, 0.75–1.5

cm. long, subfoliaceous or somewhat petaloid; calyx-lobes narrowly oblong-lanceolate, acute to acuminate, 1.0–1.5 cm. long, subfoliaceous or somewhat petaloid, glabrous; corolla tubular-salverform, densely papillate without, the tube straight, 0.75–1.0 cm. long, about 0.1 cm. in diameter at the base, the lobes obliquely ovate, 0.2–0.3 cm. long, erect or essentially so; stamens inserted somewhat above midway within the corolla-tube, the anthers 0.5 cm. long, truncate or somewhat concave at the base; ovary oblong-ovoid, about 0.1 cm. long, glabrous; stigma 0.3 cm. long; nectaries 5, compressed-obovoid, about half as long as the ovary; follicles slightly falcate, continuous, 15–20 cm. long, minutely puberulent-papillate to glabrate; seeds 0.75 cm. long, the pale tawny coma about 1.5 cm. long.

BRAZIL: MINAS GERAES: Lagoa Santa, 1864, *Warming s. n.* (C, NY); data incomplete: Dec., 1846, *Regnell II 186* (FM, S, US); *Claussen s. n.* (BB, BM, K, NY); *Widgren 581* (G, S, US); SÃO PAULO: data incomplete: *Lund s. n.* (C); *Weddell s. n.* (BM); PARANA: Jaguariahyva, in fruticetis, alt. 740 m., Nov. 26, 1914, *Dusen 15946* (MBG, NY); Turma, ad marg. silvulas, Jan. 23, 1910, *Dusen 9086* (G, US); Capão Bonito, in campo fruticosa, alt. 790 m., March 28, 1915, *Dusen 16998* (G).

PARAGUAY: in regione fl. Alto Parana, 1909–10, *Fiebrig 6373* (G, US).

URUGUAY: Montevideo, date lacking, *Sello s. n.* (BM, Camb.).

ARGENTINA: MISIONES: Posadas, Bonpland, in campo inter frutices, Dec. 28–29, 1907, *Ekman 1594* (MBG).

A full discussion of the many reasons for merging *Laseguea* with *Mandevilla* has been given in Ann. Mo. Bot. Gard. **19**: 62–63. 1932. The unusually long and cumbersome list of synonyms testifies to the variability of *M. erecta*. It will be observed, furthermore, that with the exception of the several species proposed by de Candolle, the categories into which the species has been divided have been of varietal, formal, or lesser rank. Even with the comparatively few specimens which have been available for the present study of the species, it has seemed advisable not to recognize the many minor divisions proposed by Mueller-Argoviensis, since all are based upon intergrading factors such as degree and character of indument, size and shape of leaves, color of desiccated specimens, etc.

26. **Mandevilla congesta** (HBK.) Woodson, comb. nov.

Echites congesta HBK. Nov. Gen. **3**: 214. 1819; A. DC. in DC. Prodr. **8**: 466. 1844; Miers, Apoc. So. Am. 200. 1878.

Echites pubescens R. & S. Syst. **4**: 796. 1819; A. DC. loc. cit. 476. 1844, not Hook. & Arn.

Dipladenia Fendleri Muell.-Arg. Linnaea **30**: 417. 1860.

Prestoniopsis pubescens (R. & S.) Muell.-Arg. Bot. Zeit. **18**: 22. 1860; Miers, loc. cit. 166. 1878.

Dipladenia stenoloba Heurck & Muell.-Arg. in Van Heurck, Pl. Nov. Herb. Heurck. **2**: 158. 1870.

Amblyanthera congesta Müll. ex Miers, loc. cit. 200. 1878, sphalm in synon.

Prestoniopsis hirsuta Miers, loc. cit. 167. 1878.

Prestoniopsis venosa Miers, loc. cit. 1878.

Prestoniopsis Fendleri (Muell.-Arg.) Miers, loc. cit. 168. 1878.

Dipladenia congesta (HBK.) K. Sch. in Engl. & Prantl, Nat. Pflanzenfam. **4**^{2}: 169. 1895.

Suffruticose lianas; stems terete, relatively stout, shaggy-pilose or pilosulose to glabrate; leaves opposite, petiolate, broadly oblong-elliptic to obovate-oblong, apex abruptly acuminate, base broadly and rather obscurely cordate, 6–15 cm. long, 3–9 cm. broad, membranaceous, above sparsely pilosulose to glabrate, sparsely glandular along the midrib, beneath finely tomentulose; petiole 1–3 cm. long; nodal appendages minute; inflorescence lateral or subterminal, simply racemose, usually somewhat shorter than the subtending leaves, bearing 7–20 white or yellowish flowers congested toward the upper half of the peduncle; pedicels 1.0–1.5 cm. long; bracts narrowly oblong to linear-lanceolate, 0.5–2.0 cm. long, subfoliaceous or somewhat petaloid; calyx-lobes linear-lanceolate, acuminate, 0.75–1.0 cm. long, sparsely pilosulose, the squamellae in alternate groups of 2–6; corolla salverform, glabrous without, the tube straight, 0.75–1.25 cm. long, about 0.2 cm. in diameter at the base, the lobes obliquely oblong-elliptic, long-acuminate, 1.25–1.5 cm. long, widely spreading; stamens inserted toward the base of the corolla-tube, the anthers 0.3 cm. long, truncate or merely somewhat concave at the base; ovary oblong-ovoid, about 0.1 cm. long, glabrous; stigma 0.2 cm. long; nectaries usually 2, ⅓–½ as long as the ovary; follicles unknown.

COLOMBIA: CUNDINAMARCA: Bogota, alt. 2700 m., 1851–57, *Triana 1909* (BM);

same locality, Jan., 1826, *Purdie s. n.* (K); *Tracey 297* (K); *Mutis s. n.* (BM, US, MBG, photograph).

ECUADOR: TUNGURAHUA: in sylvis, alt. 7000 ft., May, 1858, *Spruce 5390* (B, C, Camb., G, K, V).

VENEZUELA: MERIDA: prope coloniam Tovar, 1854–55, *Fendler 1030* (BB, G, K, MBG); same locality, April 9, 1859, *Crueger s. n.* (K); Mucuruba, quebrada del pueblo, alt. 2700–2800 m., June 27, 1930, *Gehriger 262* (MBG, US).

27. **Mandevilla Achrestogyne** Woodson, comb. nov.

Dipladenia Achrestogyne Woodson, Ann. Mo. Bot. Gard. **18:** 543. 1931.

Suffruticose lianas; stems terete, relatively stout, glabrous; leaves opposite, petiolate, broadly ovate-oblong, apex shortly acuminate, base broadly and rather obscurely cordate, 5–9 cm. long, 2.5–6.0 cm. broad, firmly membranaceous, glabrous, glandular at the base of the midrib above; petiole 0.5–1.5 cm. long; nodal appendages minute; inflorescence lateral, alternate, simply racemose, about as long as the subtending leaves, bearing 5–15 greenish or pale yellow flowers; pedicels 0.5 cm. long; bracts ovate-lanceolate, 0.5–0.7 cm. long, scarious; calyx-lobes lanceolate, acute to acuminate, 0.3–0.4 cm. long, scarious, glabrous, the squamellae indefinitely distributed; corolla salverform, glabrous without, the tube straight, 1.5–1.75 cm. long, about 0.125 cm. in diameter at the base, the lobes obliquely obovate-oblong, 0.75–1.0 cm. long, spreading; stamens inserted somewhat below midway within the corolla-tube, the anthers 0.5 cm. long, truncate or slightly concave at the base; ovary oblongoid, about 0.1 cm. long, glabrous; stigma 0.35 cm. long; nectaries 2–5, extremely inconspicuous; follicles unknown.

COLOMBIA: CUNDINAMARCA: rocky canyon, Chapinero, near Bogota, alt. 2800–2900 m., Sept. 18–23, 1917, *Pennell 2034* (NY, TYPE, MBG, photograph and analytical drawings).

28. **Mandevilla bogotensis** (HBK.) Woodson, Ann. Mo. Bot. Gard. **19:** 73. 1932.

Echites bogotensis HBK. Nov. Gen. **3:** 215. *pl. 243.* 1819.

Amblyanthera Bogotensis (HBK.) Muell.-Arg. Linnaea **30:** 452. 1860.

Anartia Bogotensis (HBK.) Miers, Apoc. So. Am. 82. 1878.

Suffruticose lianas; stems terete, relatively stout, glabrous; leaves opposite, petiolate, oblong- to obovate-elliptic, apex

acuminate, base obscurely cordate, 5–9 cm. long, 2.5–3.5 cm. broad, subcoriaceous, above glabrous, glandular at the base of the midrib, beneath minutely granular-papillate; petiole 0.75–1.0 cm. long; nodal appendages minute; inflorescence lateral, opposite, simply racemose, much shorter than the leaves, bearing 6–10 greenish-white flowers; pedicels 0.2–0.4 cm. long; bracts minutely ovate, scarious; calyx-lobes ovate-oblong, acute to acuminate, 0.25–0.3 cm. long, scarious, glabrous, the squamellae in alternate groups of 4–6; corolla salverform, glabrous without, the tube straight, 0.75 cm. long, about 0.1 cm. in diameter at the base, the lobes obliquely obovate-oblong, 1.25 cm. long, spreading; stamens inserted somewhat below midway within the corolla-tube, the anthers 0.5 cm. long, slightly concave at the base; ovary oblongoid, about 0.1 cm. long, glabrous; stigma 0.25 cm. long; nectaries completely obsolete; follicles unknown.

COLOMBIA: exact locality and date lacking, *Mutis s. n.* (US, ISOTYPE, MBG, photograph and analytical drawings).

29. **Mandevilla subpaniculata** Woodson, Ann. Mo. Bot. Gard. 19: 71. 1932.

Echites macrophylla A. Zahlbr. Ann. K. K. Naturh. Hofmus. Wien 7: 5. 1892, not HBK.

Suffruticose lianas; stems terete, relatively stout, minutely puberulent when young, soon becoming glabrate; leaves opposite, petiolate, ovate to broadly ovate-oblong, occasionally suborbicular, apex abruptly acuminate to obtuse or rounded, base broadly cordate, 15–20 cm. long, 10–13 cm. broad, membranaceous, above densely puberulent, glandular at the base of the midrib, beneath finely tomentulose to puberulent; petiole 3–5 cm. long; nodal appendages very inconspicuous; inflorescence lateral or subterminal, alternate, rather obscurely subpaniculate, about half as long as the subtending leaves, bearing 10–20 white or yellowish flowers; pedicels 0.5 cm. long; bracts minutely ovate, scarious; calyx-lobes ovate-trigonal, acute, 0.2 cm. long, scarious, densely puberulent-papillate without, the squamellae in alternate groups of 2–6; corolla salverform, finely puberulent-papillate without, the tube straight, 1.25 cm. long, about 0.125 cm. in diameter at the base, the lobes obliquely obovate, 1.0–1.25 cm.

long, spreading; stamens inserted near the base of the corolla-tube, the anthers 0.5–0.6 cm. long, slightly concave at the base; ovary oblongoid, about 0.1 cm. long, glabrous; stigma 0.3 cm. long; nectaries completely obsolete; follicles unknown.

ECUADOR: CHIMBORAZO: Rio Chasman, date lacking, *Spruce s. n.* (K, V, MBG, photograph and analytical drawings); PICHINCHA: Tambillo, July 9, 1878, *Jelski 32* (V, TYPE, MBG, photograph and analytical drawings).

Sect. 4. TENUIFOLIAE Woodson. Corolla salverform; nectaries 2; anthers broadly elliptic to ovate, inconspicuously auriculate; erect or ascending, suffrutescent herbs (infrequently twining in *M. tenuifolia*) of South America. *Spp. 30–31.*

KEY TO THE SPECIES

a. Leaves linear to narrowly oblong, rarely narrowly elliptic, 3–12 cm. long; peduncles scarcely surpassing the foliage; squamellae in groups of 4–6. .... *30. M. tenuifolia*

aa. Leaves filiform, 0.5–1.0 cm. long; peduncles greatly surpassing the foliage; squamellae geminate .... *31. M. myriophyllum*

30. Mandevilla tenuifolia (Mikan) Woodson, comb. nov.

Echites tenuifolia Mikan, Fl. & Faun. Bras. fasc. 3. 1820; Stadelm. Flora 24^1: Beibl. 53. 1841.

Echites pastorum Mart. ex Stadelm. loc. cit. 52. 1841.

Echites peduncularis Stadelm. loc. cit. 54. 1841.

Dipladenia pastorum (Mart.) A. DC. in DC. Prodr. **8:** 482. 1844.

Dipladenia tenuifolia (Mikan) A. DC. loc. cit. 1844.

Dipladenia tenuifolia (Mikan) A. DC. β. *puberula* A. DC. loc. cit. 1844.

Dipladenia tenuifolia (Mikan) A. DC. γ. *volubilis* A. DC. loc. cit. 1844.

Dipladenia peduncularis (Stadelm.) A. DC. loc. cit. 1844.

Dipladenia linariaefolia A. DC. loc. cit. 1844.

Dipladenia vincaeflora Lem. Fl. Serres & Jard. 2^8: *pl. 6.* 1846.

Dipladenia polymorpha Muell.-Arg. in Mart. Fl. Bras. 6^1: 121. 1860.

Dipladenia polymorpha Muell.-Arg. α. *tenuifolia* (Mikan) Muell.-Arg. loc. cit. *pl. 36.* 1860.

Dipladenia polymorpha Muell.-Arg. α. *tenuifolia* (Mikan) Muell.-Arg. *1*. *glabra* Muell.-Arg. loc. cit. 1860.

Dipladenia polymorpha Muell.-Arg. α. *tenuifolia* (Mikan) Muell.-Arg. *2*. *volubilis* (A. DC.) Muell.-Arg. loc. cit. 1860.

Dipladenia polymorpha Muell.-Arg. α. *tenuifolia* (Mikan) Muell.-Arg. *3*. *puberula* (A. DC.) Muell.-Arg. loc. cit. 1860.

Dipladenia polymorpha Muell.-Arg. β. *intermedia* Muell.-Arg. loc. cit. 1860.

Dipladenia polymorpha Muell.-Arg. γ. *peduncularis* (Stadelm.) Muell.-Arg. loc. cit. 122. 1860.

Dipladenia polymorpha Muell.-Arg. δ. *brevifolia* Muell.-Arg. loc. cit. 1860.

Homaladenia tenuifolia (Mikan) Miers, Apoc. So Am. 164. *pl. 24A*. 1878.

Homaladenia linariaefolia (A. DC.) Miers, loc. cit. 1878.

Homaladenia pastorum (Stadelm.) Miers, loc. cit. 1878.

Homaladenia peduncularis (Stadelm.) Miers, loc. cit. 165. 1878.

Homaladenia puberula (A. DC.) Miers, loc. cit. 1878.

Homaladenia brevifolia (Muell.-Arg.) Miers, loc. cit. 1878.

Homaladenia vincaeflora (Lem.) Miers, loc. cit. 1878.

Dipladenia tenuifolia (Mik.) K. Sch. in Engl. & Prantl, Nat. Pflanzenfam. 4^2: 169. 1895, sphalm.

Dipladenia pastorum (Stadelm.) A. DC. var. *tenuifolia* (Mikan) Hook. f. Bot. Mag. III. **56**: *pl. 7725*. 1900.

Dipladenia tenuifolia (Mikan) A. DC. f. *pastorum* (Stadelm.) Handel-Mzt. Denkschr. K. K. Akad. Wiss. Wien **79^2**: 11. 1910.

Erect or ascending, rarely twining, suffrutescent herbs from a fleshy, napiform root; stems terete, slender, usually minutely puberulent or pilosulose to glabrate, infrequently glabrous; leaves opposite or rarely ternate, shortly petiolate to subsessile, linear to very narrowly oblong, rarely narrowly elliptic, 3–12 cm. long, 0.2–0.75 cm. broad, membranaceous, sparsely and minutely pilosulose to glabrate; nodal appendages essentially obsolete; inflorescence lateral or subterminal, simply racemose, equalling

or scarcely surpassing the subtending leaves, bearing 2–6 bright rose-pink flowers congested toward the end of the peduncle; pedicels 0.5–0.75 cm. long; bracts minutely ovate, scarious, 0.1–0.2 cm. long; calyx-lobes broadly lanceolate, acuminate, 0.2–0.4 cm. long, scarious, glabrous, the squamellae in alternate groups of 4–6; corolla salverform, glabrous without, the tube straight, 1.5–3.0 cm. long, about 0.1 cm. in diameter at the base, the lobes obliquely obovate, 1.0–1.75 cm. long, spreading; stamens inserted near the orifice of the corolla-tube, the anthers 0.3 cm. long, obscurely auriculate; ovary oblongoid, about 0.15 cm. long, glabrous; stigma 0.15 cm. long; nectaries 2, compressed-obovoid, about half as long as the ovary; follicles somewhat falcate, continuous or very slightly articulated, 6–8 cm. long, glabrous; seeds 0.75 cm. long, the bright tawny coma about 1 cm. long.

BRAZIL: PARA: Montealegre, Serra Ituajury, April 25, 1916, *Ducke 16075* (US); campos de l'Ariramba, Dec. 2, 1910, *Ducke 11297* (US); PARAHYBA: Serra Borborema, July, 1921, *Luetzelburg 12599* (M); BAHIA: in overgrazed scrub, 30 km. west-southwest of Joazeiro, Dec. 15, 1924, *Chase 7945* (US); taboleiro bei Remariso, Dec., 1906, *Ule 7405* (K); Serra de Acurua, 1839, *Blanchet 2807* (M, NY); Serra de Monte Santo, March-April, *Martius 2267* (M); exact locality and date lacking, *Blanchet 3406* (Bx, C, MBG); GOYAZ: campinas, Duro, 1914, *Luetzelburg 383* (M); MINAS GERAES: Morro do Gaspar Suarez, date lacking, *Pohl s. n.* (M); DATA INCOMPLETE: *Glaziou 17136* (C); *Riedel s. n.* (BB, G, M); *Claussen 106* (Bx); *Martius s. n.* (M); *Regnell II 873* (US); *Miers 2418* (BM, US); *Ackermann s. n.* (Bx); *Claussen 165* (Bx); *Sello 1662* (Bx); *Sello 1313* (Bx); *Burchell 8209* (Bx); *Glaziou 15219* (Bx); *Glaziou 16250* (C); *Glaziou 15218* (C).

The great variability of this species, which is responsible for the formidable synonymy presented in detail above, does not appear to permit classification into well-marked varieties and forms at this time. It would appear that the erect or volubile habit of the plants may be largely due to ecological conditions, since it is almost invariably erect and bushy in nature, inhabiting plains or scrublands characterized by somewhat scanty rainfall, while in cultivation (cf. Van Houtte; Hook. f. *ll. cc.*) only the twining aspect has been reported. The rather tenuous indument which is present in somewhat greater or lesser degree in all specimens similarly offers little distinction for taxonomic purposes. The species is evidently a familiar object of the region which it inhabits, the fleshy underground root-stalks earning

for it the colloquial name of "batata do vaqueiro (cow-boy's potato)."

31. **Mandevilla myriophyllum** (Taub.) Woodson, comb. nov.

Dipladenia myriophyllum Taub. in Engl. Bot. Jahrb. **21**: 448. 1896.

Dipladenia acicularis K. Sch. in Glaziou, Bull. Soc. Bot. Fr. **57**: Mem. 3^{e}. 457. 1910.

Erect, subcaespitose, suffrutescent herbs; stems terete, filiform, minutely and sparsely pilosulose to glabrate or glabrous; leaves opposite to verticillate, very congested, sessile or subsessile, filiform, 0.5–1.0 cm. long, membranaceous, essentially glabrous; inflorescence terminal to subterminal, simply racemose, greatly surpassing the foliage, bearing 3–8 bright rose-pink flowers toward the distal half of the peduncle; pedicels 0.5–1.0 cm. long; bracts linear, 0.1–0.3 cm. long, scarious; calyx-lobes lanceolate, long-acuminate, 0.2–0.3 cm. long, scarious, glabrous, the alternate squamellae geminate; corolla salverform, glabrous without, the tube straight, 1.0–1.5 cm. long, somewhat less than 0.1 cm. in diameter at the base, the lobes obliquely obovate, 0.75 cm. long, reflexed or widely spreading; stamens inserted near the orifice of the corolla-tube, the anthers 0.25 cm. long, obscurely auriculate; ovary ovoid-oblongoid, about 0.75 cm. long, glabrous; stigma 0.5 cm. long; nectaries 2, compressed-obovoid, about as long as the ovary; follicles unknown.

BRAZIL: GOYAZ: Serra da Baliza, Jan. 4, 1896, *Glaziou 21721* (Bx, MP, US); exact locality lacking, Nov., 1892, *Ule 14747* [*324*] (B, TYPE, US, MBG, photograph and analytical drawings).

Very closely related to *M. tenuifolia* and possessing a fleshy, tuberous root-stalk similar to that of the latter species. The type specimen of *Dipladenia acicularis* K. Sch. (*Glaziou 21722a* in Hb. Berol.) appears at first examination to merit taxonomic designation, having somewhat longer, sparser foliage, and taller stems. Duplicate specimens of the type collection, however, plainly show these characters to be too unstable for use as specific criteria.

Sect. 5. LAXAE Woodson. Corolla infundibuliform; nectaries 2–5; anthers narrowly oblong to oblong-ovate, auriculate to

truncate; lianas and suffrutescent herbs of Mexico, Central and South America. *Spp. 32–77.*

KEY TO THE SPECIES

a. Lianas; inflorescence lateral, or occasionally subterminal.
b. Nectaries 5.
c. Nectaries about as long as the ovary, or somewhat longer; species of Mexico.
d. Corolla 2–3 cm. long, the proper-tube about as long as the throat, markedly constricted at the insertion of the stamens...*32. M. oaxacana*
dd. Corolla 1.0–1.6 cm. long, the proper-tube much shorter than the throat, not markedly constricted at the insertion of the stamens.
e. Leaves broadly cordate, 8–12 cm. long; inflorescence secund.... ....*33. M. convolvulacea*
ee. Leaves not cordate, at least the upper, 2–5 cm. long; inflorescence not secund... ....*34. M. Andrieuxii*
cc. Nectaries shorter than the ovary; species of Central and South America.
d. Anthers truncate, not emarginate or auriculate.
e. Corolla greenish-white or cream-colored.
f. Corolla 1.0–1.25 cm. long, the proper-tube scarcely narrower than the throat..........................*35. M. equatorialis*
ff. Corolla 3.5–4.0 cm. long, the proper-tube much narrower than the throat.................................*36. M. albo-viridis*
ee. Corolla rich reddish-purple....................*37. M. veraguasensis*
dd. Anthers auriculate or emarginate at the base.
e. Leaves glandular at the base of the midrib only.
f. Inflorescences opposite, or potentially so..........*38. M. glandulosa*
ff. Inflorescences alternate only.
g. Corolla greenish-white or cream-colored; nectaries essentially uniform.
h. Squamellae in groups alternate with the calyx-lobes or indefinitely distributed.
i. Calyx-lobes much shorter than the proper-tube of the corolla; leaves broadly ovate to oblong-elliptic, abruptly acuminate...................*39. M. subcordata*
ii. Calyx-lobes about as long as the proper-tube of the corolla or somewhat longer; leaves ovate to broadly ovate-elliptic, long-acuminate.
j. Leaves uniformly puberulent beneath; corolla-throat greatly surpassing the proper-tube; plants of Bolivia and southern Peru..........*40. M. Bridgesii*
jj. Leaves barbate in the axils of the midrib beneath; corolla-throat about as long as the proper-tube or somewhat longer; species of northern Argentina and southern Bolivia.
k. Corolla 4–8 cm. long, the lobes about as long as the throat...............................*41. M. laxa*

kk. Corolla 2.5–3.0 cm. long, the lobes about half as long as the throat........................*42. M. grata*

hh. Squamellae solitary and opposite the calyx-lobes..*43. M. funiformis*

gg. Corolla pink; nectaries more or less dissimilar.*44. M. Luetzelburgii*

ee. Leaves sparsely glandular the length of the midrib; corolla-tube white or cream-colored, the limb shading to deep rose and bronze at the margin..............................*45. M. callista*

bb. Nectaries predominantly 2, rarely as many as 5 in some species.

c. Nodes conspicuously appendiculate throughout.

d. Leaves coriaceous.

e. Corolla-throat broadly conical or campanulate.......*46. M. Martiana*

ee. Corolla-throat narrowly conical to subtubular.

f. Corolla-throat longer than the proper-tube........*47. M. crassinoda*

ff. Corolla-throat about as long as the proper-tube.

g. Leaves oblong to obovate-elliptic, 4–8 cm. long; plants of Venezuela and Dutch Guiana.............*48. M. surinamensis*

gg. Leaves suborbicular to broadly obovate, 1.5–4.0 cm. long; species of northeastern Brazil.

h. Inflorescence subterminal, terminating short lateral branches; leaves obovate to orbicular-obovate, the base more or less cuneate..............*49. M. Moricandiana*

hh. Inflorescence strictly lateral; leaves orbicular-obovate to suborbicular, the base rounded, not cuneate..*50. M. eximia*

dd. Leaves membranaceous (see also *M. surinamensis*).

e. Corolla-throat conical to campanulate.

f. Plants more or less pubescent, at least the foliage; corolla 6–8 cm. long.

g. Leaves sessile or subsessile; corolla-throat nearly as broad as long..................................*51. M. splendens*

gg. Leaves long-petiolate; corolla-throat nearly twice as long as broad...............................*52. M. oblongifolia*

ff. Plants glabrous; corolla 4–5 cm. long.................*53. M. glabra*

ee. Corolla-throat tubular.

f. Corolla-limb about as long as the throat; leaves oblong-elliptic, cordate...............................*54. M. superba*

ff. Corolla-limb much shorter than the throat; leaves linear to linear-lanceolate (infrequently oblong-elliptic in *55*).

g. Corolla 7–8 cm. long.......................*55. M. angustifolia*

gg. Corolla about 3 cm. long.......................*56. M. minor*

cc. Nodes exappendiculate, or essentially so, at least above.

d. Corolla white, pinkish, or yellow, the limb reflexed or widely spreading.

e. Leaves distinctly petiolate, the base cuneate to rounded, never deeply cordate and amplexicaul (occasionally obscurely cordate in *62–63*).

f. Corolla white or yellowish.

g. Leaves membranaceous........................*57. M. cereola*

gg. Leaves coriaceous.

h. Corolla 5–8 cm. long; calyx-lobes scarious.
i. Corolla-throat conical to campanulate.
j. Corolla-throat conical-campanulate; calyx-lobes 0.5–0.6 cm. long .... *58. M. fragrans*
jj. Corolla-throat strictly conical; calyx-lobes 0.2–0.3 cm. long .... *59. M. permixta*
ii. Corolla-throat subtubular to narrowly conical.
j. Plants glabrous.
k. Corolla-lobes 2–3 cm. long, about as long as the throat, conspicuously acuminate; plants of Bolivia and Ecuador .... *60. M. boliviensis*
kk. Corolla-lobes 3.5–4.0 cm. long, longer than the throat, scarcely acuminate; plants of Venezuela. .... *61. M. bella*
jj. Plants scabrous to glabrate, minutely hirtellous when young; plants of Brazil .... *62. M. Muelleri*
hh. Corolla 3.0–3.5 cm. long; calyx-lobes subfoliaceous . . *63. M. lucida*
ff. Corolla pink, at least the limb.
g. Corolla 5–9 cm. long, rich pink throughout, the lobes obovate, acuminate, as long as the throat or somewhat longer.
h. Corolla-throat conical; leaves glandular.
i. Leaves narrowly elliptic, the base somewhat cuneate, dark green above .... *64. M. Sellowii*
ii. Leaves broadly oblong-elliptic, the base rounded or obscurely cordate, glaucous above .... *65. M. Sanderi*
hh. Corolla-throat campanulate; leaves eglandular .... *66. M. immaculata*
gg. Corolla 4.0–4.5 cm. long, the lobes pink, broadly obovate-reniform, scarcely acuminate, much shorter than the yellowish throat .... *67. M. urophylla*
ee. Leaves sessile or subsessile, the base deeply cordate and more or less amplexicaul .... *68. M. venulosa*
dd. Corolla reddish-purple, or the proper-tube reddish-purple and the throat and limb white or cream-colored, the limb erect or only slightly spreading.
e. Corolla dark reddish purple throughout, the lobes obliquely obovate to obovate-reniform .... *69. M. atroviolacea*
ee. Corolla-throat reddish violet, otherwise white or cream-colored, the lobes ovate-oblong to narrowly oblong-elliptic . . . . *70. M. pendula*
aa. Erect or ascending, suffrutescent herbs; inflorescence terminal, rarely subterminal.
b. Corolla-throat conical to campanulate, or if tubular-conical not narrowing toward the orifice.
c. Leaves coriaceous .... *71. M. sancta*
cc. Leaves membranaceous to somewhat chartaceous.
d. Corolla rich pink or reddish; nectaries 2, essentially uniform and entire; plants of southeastern Brazil .... *72. M. illustris*

dd. Corolla pale pink or cream flushed with rose; nectaries 2–5, more or less dissimilar, and usually lobed when fewer than 5; plants of Bolivia and southern Peru.....................*73. M. cuspidata*

bb. Corolla-throat tubular, slightly narrowing toward the orifice.

c. Corolla-throat relatively large, 2.75–5.0 cm. long, 0.75–1.25 cm. in diameter at the orifice.

d. Leaves ovate or obovate to ovate- or obovate-oblong....*74. M. velutina*

dd. Leaves linear......................................*75. M. linearis*

cc. Corolla-throat relatively small, 0.7–1.5 cm. long, 0.3–0.5 cm. in diameter at the orifice.

d. Corolla-throat about as long as the proper-tube.........*76. M. coccinea*

dd. Corolla-throat much longer than the proper-tube..*77. M. spigeliaeflora*

32. **Mandevilla oaxacana** (A. DC.) Hemsl. Biol. Centr.-Am. Bot. **2**: 316. 1882.

Echites hirtella Humb. et Kunth, acc. to Benth. Pl. Hartw. 67. 1839, not HBK. Nov. Gen. **3**: 213. 1819.

Echites Oaxacana A. DC. in DC. Prodr. **8**: 451. 1844.

?*Echites cordata* A. DC. loc. cit. 1844.

Echites glaucescens Mart. & Gal. Bull. Acad. Roy. Brux. **11**[1]: 358. 1844.

Amblyanthera Oaxacana (A. DC.) Muell.-Arg. Linnaea **30**: 447. 1860.

?*Temnadenia cordata* (A. DC.) Miers, Apoc. So. Am. 212. 1878.

Temnadenia glaucescens (Mart. & Gal.) Miers, loc. cit. 214. 1878.

Mesechites Oaxacana (A. DC.) Miers, loc. cit. 234. 1878.

Mesechites hirtellula Miers, loc. cit. 1878.

Mandevilla Schumanniana Loes. Bull. Herb. Boiss. **2**: 556. 1894.

Suffruticose lianas; stems terete, relatively slender, glabrous, or infrequently sparsely and minutely pilosulose when young; leaves opposite, petiolate, lanceolate to ovate-lanceolate, apex acuminate, base rather obscurely cordate, 3–9 cm. long, 0.75–4.5 cm. broad, membranaceous, above glabrous, glandular at the base of the midrib, beneath sparsely and irregularly pilosulose to glabrate; petiole 0.5–2.0 cm. long; nodal appendages minute; inflorescence subterminal or lateral, alternate, simply racemose, about as long as the subtending leaves, bearing 3–8 rather distant, yellowish flowers; pedicels 0.75–1.25 cm. long; bracts lanceolate,

about 0.2 cm. long, scarious; calyx-lobes narrowly ovate-trigonal, acuminate, 0.2–0.3 cm. long, scarious, glabrous, the squamellae indefinitely distributed; corolla infundibuliform, glabrous without, the proper-tube straight, 0.8–1.2 cm. long, about 0.2 cm. in diameter at the base, the throat rather narrowly conical-campanulate, about as long as the proper-tube, about 0.75 cm. in diameter at the orifice, the lobes obliquely obovate, 0.5 cm. long, spreading; stamens inserted at the constriction of the corolla-tube, the anthers 0.4 cm. long, obscurely auriculate; ovary ovoid, about 0.2 cm. long, minutely pilose; stigma 0.3 cm. long; nectaries 5, compressed-oblongoid, as long as the ovary or somewhat longer; follicles somewhat falcate, relatively slender, obscurely articulated, 8–10 cm. long, glabrous; seeds 1.0 cm. long, the pale tawny coma of about equal length.

MEXICO: OAXACA: hills near Oaxaca, alt. 6000 ft., May 25, 1906, *Pringle 13760* (C, G, S, US); hills, San Felipe de Agua, alt. 1800 ft., Sept. 1, 1895, *Conzatti 578* (G); Cerro San Felipe, Aug., 1918, *Reko 3955* (US); dry ledges of foothills above Oaxaca, alt. 6000 ft., May 29, 1894, *Pringle 4662* (Bx, BM, G, MBG, NY); Puente de Gia, 1839, *Hartweg 492* (BM, Camb., K); eastern cordillera of Oaxaca, alt. 7000 ft., date lacking, *Galeotti 1582* (Bx, DL, K); prope Misla, Distr. Tlacolula, June, 1888, *Seler & Seler 39* (B, BB, G); Rio Frio, June, 1842, *Liebmann 11981* (C, FM, US); Tehuantepec, in reg. mont., alt. 7000 ft., July, 1900, *Gonzalez s. n.* (V); exact locality lacking, April, 1834, *Andrieux 248* (DC, TYPE, K).

33. **Mandevilla convolvulacea** (A. DC.) Hemsl. Biol. Centr.-Am. Bot. **2**: 316. 1882.

Echites convolvulacea A. DC. in DC. Prodr. **8**: 451. 1844, not acc. to Miers, Apoc. So. Am. 195. 1878.

Amblyanthera convolvulacea (A. DC.) Muell.-Arg. Linnaea **30**: 423. 1860.

Suffruticose lianas; stems terete, relatively slender, minutely puberulent when young, soon becoming glabrate; leaves opposite, petiolate, ovate to ovate-oblong, acuminate, broadly cordate, 8–12 cm. long, 3–7 cm. broad, membranaceous, above minutely puberulent when young, becoming sparsely hispidulous to glabrate, glandular at the base of the midrib, beneath densely puberulent to tomentulose, particularly along the veins; petiole 1.0–1.5 cm. long; nodal appendages minute; inflorescence lateral, simply racemose, conspicuously longer than the subtending leaves, bearing 10–15 secund, yellowish flowers; pedicels 0.8–1.25

cm. long; bracts narrowly lanceolate, 0.5–0.8 cm. long; calyx-lobes ovate-lanceolate, acuminate, 0.2–0.3 cm. long, scarious, glabrous or very sparsely pilosulose, the squamellae indefinitely distributed; corolla infundibuliform, glabrous without, the proper-tube straight, 0.3–0.4 cm. long, about 0.15 cm. in diameter at the base, not constricted at the insertion of the stamens, the throat conical, 0.5–0.7 cm. long, about 0.5 cm. in diameter at the orifice, the lobes obliquely obovate, shortly acuminate, 0.5 cm. long, widely spreading; anthers auriculate, 0.3–0.4 cm. long; ovary ovoid, about 0.1 cm. long, glabrous; nectaries 5, ovoid-oblongoid, about as long as the ovary; follicles unknown.

MEXICO: PUEBLA: Bartolo, in calidis, date lacking, *Karwinski 269* (Bx); OAXACA: mountains, San Juan del Estado, alt. 7000 ft., Aug. 13, 1894, *L. C. Smith 257* (G); Rio Blanco, San Juan del Estado, alt. 4500 ft., June 29, 1895, *L. C. Smith 468* (G); Chiconemchitl, June, 1842, *Liebmann 11970* (C, FM, US); DATA INCOMPLETE: "Peruvia," *Pavon s. n.* (BB, TYPE, MBG, photograph and analytical drawings).

The error of ascribing a Peruvian origin to this species was pointed out by Mueller-Argoviensis (loc. cit. 1860). Nevertheless Miers (loc. cit. 1878) gives Peru and Bolivia as provenience of the species, citing *Mandon 1472* from Sorata, Bolivia, a specimen more correctly referable to *M. Bridgesii* (Muell.-Arg.) Woodson.

34. **Mandevilla Andrieuxii** (Muell.-Arg.) Hemsl. Biol. Centr.-Am. Bot. **2**: 316. 1882.

Amblyanthera Andrieuxii Muell.-Arg. Linnaea **30**: 422. 1860.

Echites Andrieuxii (Muell.-Arg.) Miers, Apoc. So. Am. 206. 1878.

Mesechites Andrieuxii (Muell.-Arg.) Miers, loc. cit. 235. 1878.

Suffruticose lianas; stems relatively slender, terete, minutely puberulent when very young, soon becoming glabrate; leaves opposite, petiolate, narrowly obovate to obovate-lanceolate, apex acute to abruptly acuminate, base broadly obtuse to rounded, not cordate, 2–5 cm. long, 0.8–1.5 cm. broad, membranaceous, above puberulent to minutely and sparsely hispidulous, glandular at the base of the midrib, beneath densely puberulent to tomentulose; petiole 0.3–0.5 cm. long; nodal appendages minute; inflorescence lateral or subterminal, simply racemose, equalling

or slightly surpassing the length of the subtending leaves, bearing 8–12 lax, yellowish flowers; pedicels 0.8–1.0 cm. long; bracts narrowly lanceolate, 0.3–0.6 cm. long; calyx-lobes ovate-lanceolate, acuminate, 0.4–0.5 cm. long, scarious, sparsely puberulent, the squamellae indefinitely distributed; corolla infundibuliform, glabrous without, the proper-tube straight, 0.3–0.4 cm. long, about 0.15 cm. in diameter at the base, not constricted at the insertion of the stamens, the throat conical, 0.5–0.6 cm. long, about 0.6 cm. in diameter at the orifice, the lobes obliquely obovate, 3–4 cm. long, widely spreading; anthers auriculate, 0.4 cm. long; ovary ovoid, about 0.1 cm. long, glabrous; nectaries 5, ovoid-oblongoid, about as long as the ovary; follicles unknown.

MEXICO: OAXACA: San Francisco, inter Ilapan et Oaxacam, date lacking, *Andrieux 249* (BB, DC, TYPE, MBG, photograph and analytical drawings); Chiconesochitl, June, 1842, *Liebmann 11976* (C, FM).

35. **Mandevilla equatorialis** Woodson, Ann. Mo. Bot. Gard. 19: 65. 1932.

Suffruticose lianas; stems terete, relatively slender, minutely puberulent when young, soon becoming glabrate; leaves opposite, petiolate, ovate-oblong, apex rather abruptly acuminate, base broadly and obscurely cordate, 2–5 cm. long, 1.0–1.25 cm. broad, firmly membranaceous, above minutely puberulent to glabrate, glandular at the base of the midrib, beneath densely and minutely tomentulose; petiole 0.3–0.7 cm. long; nodal appendages minutely pectinate; inflorescence lateral or subterminal, alternate, simply racemose, about twice as long as the subtending leaves, bearing 8–14 yellowish flowers; pedicels 0.4 cm. long; bracts lanceolate, 0.2–0.3 cm. long, scarious; calyx-lobes lanceolate, acuminate, 0.2 cm. long, minutely puberulent-papillate, the squamellae in alternate groups of 3–5; corolla infundibuliform, minutely puberulent-papillate without, the proper-tube straight, 0.2 cm. long, about 0.1 cm. in diameter at the base, the throat narrowly conical, 0.5–0.7 cm. long, about 0.4 cm. in diameter at the orifice, the lobes obliquely obovate-lanceolate, acuminate, 0.3 cm. long, spreading; stamens inserted at the base of the corolla-throat, the anthers truncate, 0.3–0.4 cm. long; ovary ovoid, about 0.1

cm. long, glabrous; nectaries 5, compressed-obovoid, about half as long as the ovary; mature follicles unknown.

ECUADOR: vicinity of Tablon de Oña, Sept. 27, 1918, *Rose Pachano & Rose 23029* (US, TYPE, MBG, photograph and analytical drawings).

36. **Mandevilla albo-viridis** (Rusby) Woodson, Ann. Mo. Bot. Gard. **19**: 69. 1932.

Dipladenia alba-viridis Rusby, Descr. So. Am. Pl. 86. 1920.

Suffruticose lianas; stems terete, relatively stout, minutely and sparsely puberulent when very young, soon becoming glabrate; leaves opposite, petiolate, ovate- to oblong-elliptic, apex abruptly acuminate, base broadly and rather obscurely cordate, 6–11 cm. long, 2.5–7.0 cm. broad, firmly membranaceous, above glabrous, glandular at the base of the midrib, beneath minutely puberulent-tomentulose, particularly along the veins and midrib; petiole 1.5–2.5 cm. long; nodal appendages 0.1–0.2 cm. long, coriaceous; inflorescence lateral, alternate, simply racemose, about half as long as the subtending leaves, bearing 3–5 lax, greenish-white flowers toward the end of the peduncle; pedicels 1.25 cm. long; bracts minutely ovate, scarious; calyx-lobes ovate-lanceolate, narrowly acute, 0.3 cm. long, scarious, glabrous, the squamellae in alternate groups of 3–6; corolla infundibuliform, glabrous without or essentially so, the proper-tube straight, 0.7–0.8 cm. long, about 0.15 cm. in diameter at the base, the throat narrowly conical, 1.5–1.75 cm. long, about 0.7 cm. in diameter at the orifice, the lobes obliquely obovate, acuminate, 1.2–1.5 cm. long, spreading; anthers truncate, 0.8 cm. long; ovary oblongoid, 0.3 cm. long, glabrous; nectaries (? 2–) 5, compressed-oblongoid, about half as long as the ovary; follicles unknown.

COLOMBIA: MAGDALENA: damp forest and neglected clearings, Sierra del Libano, alt. 6000 ft., Jan. 22, 1899, *H. H. Smith 1904* (NY, TYPE, MBG, photograph and analytical drawings).

37. **Mandevilla veraguasensis** (Seem.) Hemsl. Biol. Centr.-Am. Bot. **2**: 317. 1882 (as *M. veraguensis*).

Echites (§ *Euechites*) *Veraguasensis* Seem. Bot. Voy. Herald, 168. 1852; Miers, Apoc. So. Am. 203. 1878.

Mandevilla Loesneriana K. Sch. in Engl. Bot. Jahrb. **25**: 725. 1898.

Suffruticose lianas; stems terete, relatively stout, sparsely and minutely pilose when young, soon becoming glabrate; leaves opposite, petiolate, broadly ovate to ovate-elliptic, apex shortly acuminate, base broadly cordate, 5–13 cm. long, 2.5–7.0 cm. broad, firmly membranaceous, above glabrous, or rarely minutely puberulent to glabrate, glandular at the base of the midrib, beneath minutely pilose to glabrate, occasionally glabrous; petiole 1.0–2.5 cm. long; nodal appendages 0.05–0.1 cm. long, slightly coriaceous; inflorescence lateral, alternate, simply racemose, about as long as the subtending leaves, bearing 5–12 lax, purplish flowers; pedicels 2–3 cm. long; bracts lanceolate, 0.2–0.3 cm. long, scarious; calyx-lobes ovate-trigonal, acute, 0.3–0.6 cm. long, scarious, glabrous, the squamellae in alternate groups of 6–8; corolla infundibuliform, glabrous to minutely and densely puberulent-papillate without, the proper-tube straight, 2.0–2.5 cm. long, about 0.2 cm. in diameter at the base, the throat rather broadly conical-campanulate, 1.5–2.0 cm. long, about 1 cm. in diameter at the orifice, the lobes obliquely obovate, acuminate, 2.5–3.0 cm. long, spreading; anthers truncate, 0.7 cm. long; ovary ovoid-oblongoid, about 0.3 cm. long; nectaries 5, compressed-obovoid, truncate or somewhat emarginate, somewhat less than half as long as the ovary; follicles unknown.

COSTA RICA: CARTAGO: Turrialba, 1845–48, *Ørsted 15510* (C); LIMON: San Pedro de la Calabasa, alt. 1100 m., July 26, 1888, *Pittier 369* (Bx, US).

PANAMA: CHIRIQUI: Boquete, March, 1848, *Seemann 1220* (BM, K, TYPE); forests around El Boquete, alt. 1000–1300 m., March, 1911, *Pittier 3147* (FM, US); LOS SANTOS: along Rio Caldera, March 16, 1911, *Pittier 3147* (FM).

COLOMBIA: JURADO: open trail, La Cumbre, Dept. El Valle, alt. 1600–1800 m., Sept. 11–19, 1922, *Killip 11409* (G, K, US); TOLIMA: Azufral del Quindio, Prov. Mariquita, alt. 2150 ft., July, 1853, *Triana s. n.* (BM); CAUCA: Juza, Popayan, alt. 1400–1800 m., Jan., year lacking, *Lehmann 8483* (FM, K).

VENEZUELA: MERIDA: prope coloniam Tovar, 1854–55, *Fendler 1028* (BB, Bx, K, MBG).

ECUADOR: PICHINCHA: in fruticeto ad marg. viae, Tandapi, July 11, 1920, *Holmgren 846* (S); GUAYAS: Teresita, 3 km. west of Bucay, alt. 270 m., July 5–7, 1923, *Hitchcock 20495* (NY, US).

It is doubtful whether the minutely puberulent corolla-lobes of *M. Loesneriana* should entitle it to specific recognition. *Hitchcock 20495* from the province of Guayas, Ecuador, bears corollas densely and generally velutinous without, but the construction of the flowers, as well as the vegetative characters, appears

scarcely separable from more typical specimens of *M. veraguasensis* from Colombia, Venezuela, and the type locality in northern Panama. It is possible that the recognition of a variety might satisfy our knowledge of existing specimens.

38. **Mandevilla glandulosa** (R. & P.) Woodson, Ann. Mo. Bot. Gard. **19:** 66. 1932.

Echites glandulosa R. & P. Fl. Peruv. **2:** 19. *pl. 135.* 1799; Miers, Apoc. So. Am. 196. 1878.

Prestonia peruviana Spreng. Syst. **1:** 637. 1825.

Haemadictyon glandulosum (R. & P.) A. DC. in DC. Prodr. **8:** 427. 1844.

Odontadenia glandulosa (R. & P.) K. Sch. in Engl. & Prantl, Nat. Pflanzenfam. **4²:** 169. 1895.

Suffruticose lianas; stems terete, relatively stout, softly pubescent when young, becoming glabrate; leaves opposite, petiolate, ovate to broadly ovate-lanceolate, apex acuminate, base broadly cordate, 10–15 cm. long, 6–8 cm. broad, membranaceous, above puberulent when young, becoming glabrate, glandular at the base of the midrib, beneath densely tomentulose; petiole 1.5–2.0 cm. long; nodal appendages 0.1–0.3 cm. long, somewhat coriaceous; inflorescence lateral, opposite or potentially so, simply racemose, about twice as long as the leaves, bearing 15–20 lax, greenish-white or cream-colored flowers; pedicels 3.0–3.5 cm. long; bracts lanceolate, 0.3–0.4 cm. long, scarious; calyx-lobes lanceolate, acuminate, 0.5–0.6 cm. long, scarious, puberulent, the squamellae in alternate groups of 2–4; corolla infundibuliform, glabrous or minutely papillate without, the proper-tube straight, 2.0–2.25 cm. long, about 0.2 cm. in diameter at the base, the throat narrowly conical, 1.5–1.75 cm. long, about 0.5 cm. in diameter at the orifice, the lobes obliquely obovate, shortly acuminate, 2 cm. long, spreading; anthers emarginate, 0.6 cm. long; ovary ovoid-oblongoid, 0.3 cm. long, minutely puberulent-papillate; nectaries 5, compressed-obovoid, truncate, about 0.1 cm. long; follicles stout, continuous or very slightly articulate, glabrous, 30–35 cm. long; seeds not seen.

Peru: ad Muñas, date lacking, *Pavon s. n.* (BB, type, MBG, photograph and analytical drawings); Yanano, alt. about 6000 ft., May 13–16, 1923, *Macbride 3730* (FM); exact locality and date lacking, *Weberbauer 4384* (B).

39. Mandevilla subcordata Rusby, Bull. N. Y. Bot. Gard. 4: 315. 1907.

Suffruticose lianas; stems terete, relatively stout, puberulent to glabrate; leaves opposite, petiolate, broadly ovate- to oblong-elliptic, apex abruptly acuminate, base broadly cordate, rarely obtuse or rounded, 4–10 cm. long, 2.5–5.0 cm. broad, membranaceous, above glabrous or very minutely puberulent when young, glandular at the base of the midrib, beneath densely and minutely tomentulose to glabrate; petiole 1.0–2.5 cm. long; nodal appendages relatively inconspicuous; inflorescence lateral, alternate, simply racemose, about twice as long as the subtending leaves, bearing 5–20 lax, greenish-white or cream-colored flowers; pedicels 1.0–1.25 cm. long; bracts minutely ovate, scarious; calyx-lobes ovate-lanceolate, 0.5–0.7 cm. long, scarious, minutely puberulent to glabrate, the squamellae in alternate groups of 4–6; corolla infundibuliform, glabrous without, the proper-tube straight, 1.5–2.0 cm. long, about 0.15 cm. in diameter at the base, the throat rather narrowly conical, 2.0–2.25 cm. long, about 1 cm. in diameter at the orifice, the lobes obliquely obovate, shortly acuminate, 1.5 cm. long, spreading; anthers auriculate, 0.5 cm. long; ovary ovoid-oblongoid, 0.2 cm. long, glabrous; nectaries 5, compressed-obovoid, truncate or obscurely emarginate, about 0.1 cm. long; follicles relatively stout, continuous, 20–30 cm. long, glabrous; seeds about 0.75 cm. long, the pale tawny coma about 2 cm. long.

BOLIVIA: LA PAZ: near snow-line, Mt. Tunari, 1891, *Bang 1120* (C, FM, NY, TYPE, US, MBG, photograph and analytical drawings); Yungas, alt. 4000 ft., 1885, *Rusby 2394* (NY).

40. Mandevilla Bridgesii (Muell.-Arg.) Woodson, Ann. Mo. Bot. Gard. 19: 67. 1932.

Amblyanthera Bridgesii Muell.-Arg. Linnaea 30: 420. 1860; Miers, Apoc. So. Am. 189. 1878.

Mandevilla Mandoni Britton, Bull. Torrey Bot. Club 25: 496. 1898.

Mandevilla Bangii Rusby, Bull. N. Y. Bot. Gard. 4: 315. 1907.

Suffruticose lianas; stems terete, relatively stout, glabrous or essentially so; leaves opposite, petiolate, ovate to broadly

oblong-elliptic, apex acuminate, base broadly cordate, 3–12 cm. long, 1.5–7.0 cm. broad, membranaceous, above glabrous or very minutely and sparsely puberulent when very young, glandular at the base of the midrib, beneath generally puberulent or tomentulose throughout; petiole 1–3 cm. long; nodal appendages 0.05–0.2 cm. long, somewhat coriaceous; inflorescence lateral, alternate, simply racemose, about as long as the subtending leaves or somewhat longer, bearing 4–12 lax, white or cream-colored flowers; pedicels 1.5–2.0 cm. long; bracts lanceolate, 0.2–0.5 cm. long, scarious or slightly foliaceous; calyx-lobes narrowly oblong-lanceolate, acuminate, 0.75–1.0 cm. long, slightly foliaceous, glabrous or very sparsely and minutely puberulent, the squamellae in alternate groups of 6–8; corolla infundibuliform, glabrous without or very minutely papillate, the proper-tube straight, 0.5–0.7 cm. long, about 0.2 cm. in diameter at the base, the throat tubular-conical, 1.2–2.0 cm. long, about 0.4 cm. in diameter at the orifice, the lobes obliquely obovate to obovate-oblong, shortly acuminate, 1.5–2.0 cm. long; anthers obscurely auriculate, 0.8 cm. long; ovary ovoid-oblongoid, about 0.3 cm. long, glabrous; stigma 0.3–0.4 cm. long; nectaries 5, compressed-obovoid, truncate or somewhat depressed, about 0.1 cm. long; follicles relatively stout, continuous, 15–30 cm. long, glabrous; seeds about 0.7 cm. long, the pale tawny coma about 2 cm. long.

PERU: CUZCO: Ollanteitambo, Urubamba Valley, alt. 2800 m., Febr., 1931, *Herrera 3123* (FM, MBG, US).

BOLIVIA: LA PAZ: Sorata, alt. 7500 ft., Sept. 4, 1901, *Williams 2427* (BM, K, NY); same locality, April 19, 1920, *Holway & Holway 556* (NY, US); Prov. Larecaja, viciniis Sorata, in nemoribus, undique, alt. 2500–3000 m., May 9, 186–, *Mandon 1472* (BB, BM, K, NY, S); Sorata, alt. 8000 ft., Febr., 1886, *Rusby 2386* (B, BM, Bx, FM, K, MBG, NY, US); COCHABAMBA: vicinity of Cochabamba, 1891, *Bang 1065* (B, BM, DL, FM, K, MBG, V, US); same locality and date, *Bang 1120* (K, MBG, NY); Quebrada de Pocona, alt. 2800 m., Dec. 17, 1921, *Lillo 5988* (B); Pocona, alt. 2500 m., Nov. 8, 1928, *Steinbach 8662* (FM); TARIJA: Tucumilla bei Tarija, alt. 3000 m., Dec. 30, 1903, *Fiebrig 2455* (AA, B, BM); DATA INCOMPLETE: *Bridges s. n.* (BB, TYPE, Camb., MBG, photograph).

With the accumulation of additional specimens, this species may be found to intergrade with the following, which it closely approaches in some instances.

41. Mandevilla laxa (R. & P.) Woodson, Ann. Mo. Bot. Gard. **19**: 68. 1932.

Echites laxa R. & P. Fl. Peruv. **2**: 19. *pl. 134*. 1799; A. DC. in DC. Prodr. **8**: 451. 1844; Miers, Apoc. So. Am. 197. 1878.

Mandevilla suaveolens Lindl. Bot. Reg. n. s. **3**: *pl. 7*. 1840; Miers, loc. cit. 184. 1878.

Echites suaveolens (Lindl.) A. DC. loc. cit. 452. 1844, not Mart. & Gal.

Amblyanthera suaveolens (Lindl.) Muell.-Arg. Linnaea **30**: 447. 1860.

Mandevilla Tweediana Gadeceau & Stapf, Bull. Soc. Sci. Ouest Fr. III. **3**: 2. 1913.

Suffruticose lianas; stems terete, relatively stout, glabrous, or minutely puberulent when very young; leaves opposite, petiolate, ovate, apex acuminate, base broadly cordate, 6–15 cm. long, 3–6 cm. broad, membranaceous, above glabrous, glandular at the base of the midrib, beneath barbate in the axils of the midrib, otherwise glabrous; petiole 2–3 cm. long; nodal appendages 0.5–0.8 cm. long, somewhat coriaceous; inflorescence lateral, alternate, simply racemose, conspicuously longer than the subtending leaves, bearing 5–15 white or cream-colored flowers; pedicels 1.5–2.0 cm. long; bracts lanceolate, 0.5–0.7 cm. long, scarious or slightly foliaceous; calyx-lobes lanceolate, acuminate, 0.7–1.25 cm. long, somewhat foliaceous, glabrous, the squamellae in alternate groups of 4–6, or indefinitely distributed; corolla infundibuliform, glabrous without, the proper-tube straight, 1.0–2.5 cm. long, about 0.2 cm. in diameter at the base, the throat conical, 1.5–3.0 cm. long, 0.7–1.0 cm. in diameter at the orifice, the lobes obliquely obovate, 1.5–3.0 cm. long; anthers obscurely auriculate, 1.0–1.2 cm. long; ovary ovoid-oblongoid, about 0.4 cm. long, glabrous; stigma 0.4–0.5 cm. long; nectaries 5, compressed-obovoid, truncate, about 0.1 cm. long; follicles relatively stout, continuous, 25–40 cm. long, glabrous; seeds about 0.6 cm. long, the pale tawny coma about 1.5 cm. long.

Bolivia: tarija: Toldos, bei Bermejo, alt. 1900 m., Dec. 4, 1903, *Fiebrig 2336* (AA, B, BM, G, K, S); Huayavilla, Nov., 1905, *Fiebrig 2153* (B).

Argentina: tucuman: Tucuman, Jan. 7, 1873, *Lorentz & Hieronymus s. n.* (B);

El Pesutito, Dept. Burroyaco, Nov. 22, 1928, *Venturi 7586* (MBG, US); Chaearita de los Padres, Nov. 21-24, 1872, *Lorentz & Hieronymus 403* (B); en los alrededores de la ciudad de Tucuman, Jan. 7, 1873, *Hieronymus & Lorentz s. n.* (B); Piambon, Sierra de Tucuman, March, 1872, *Lorentz 205* (B); abundant in woods of Tucuman, 1840, *Tweedie s. n.* (K); SANTIAGO DEL ESTERO: Esquina Grande, Dec. 10, 1916, *Jørgensen 1800* (MBG, US).

As far as may be ascertained, the type specimen, or at any rate a specimen which might be construed as typical, does not exist of Ruiz & Pavon's *Echites laxa.* The only two species to which this name can be applied, however, are *Mandevilla suaveolens* Lindl. and *Amblyanthera Bridgesii* Muell.-Arg. Of these, the former has not been collected in Peru, according to the available records, whereas the latter has been collected in southern Peru at least once within recent times. Both species are relatively frequent in Bolivia, however, whence it is possible that Pavon obtained his specimen. Since we must rely upon the figure given in the 'Flora Peruviana,' we find that *M. suaveolens* agrees more closely with this figure, which is characterized by the larger corolla, with correspondingly shorter calyx-lobes of the Lindleyan species.

42. **Mandevilla grata** Woodson, Ann. Mo. Bot. Gard. **19**: 68. 1932.

Suffruticose lianas; stems terete, relatively slender, glabrous, or minutely puberulent when young; leaves opposite, petiolate, ovate, acuminate, broadly cordate, 7–12 cm. long, 5–9 cm. broad, membranaceous, above glabrous or minutely puberulent when very young, beneath barbate in the axils of the midrib; petiole 2.0–3.5 cm. long; nodal appendages relatively inconspicuous; inflorescence lateral, alternate, simply racemose, about twice as long as the subtending leaves, bearing 4–12 white or cream-colored flowers toward the end of the peduncle; pedicels 1.5–2.0 cm. long; bracts lanceolate, 0.5–1.0 cm. long, scarious to slightly foliaceous; calyx-lobes narrowly oblong-lanceolate, acuminate, 1 cm. long, somewhat foliaceous, glabrous, the squamellae in alternate groups of 3–5; corolla infundibuliform, glabrous or minutely papillate without, the proper-tube straight, about 1 cm. long, about 0.3 cm. in diameter at the base, the throat tubular-conical, 1.0–1.2 cm. long, 0.4–0.5 cm. in diameter at the

orifice, the lobes obliquely obovate, 0.5–0.7 cm. long, ascending or slightly spreading; anthers obscurely auriculate, 0.8–0.9 cm. long; ovary oblongoid, about 0.2 cm. long, glabrous; stigma 0.3 cm. long; nectaries 5, ovoid-reniform, about half as long as the ovary; follicles unknown.

ARGENTINA: TUCUMAN: Muñecas, March 5, 1923, *Venturi 1769a* (BA, MBG, TYPE); Alto de la Polvora, March 28, 1922, *Venturi 1769* (BA, MBG).

43. **Mandevilla funiformis** (Vell.) K. Sch. in Engl. & Prantl, Nat. Pflanzenfam. 4²: 171. 1895.

Echites funiformis Vell. Fl. Flum. 109. 1830; Icon. 3: *pl. 29.* 1827.

Echites microphylla Stadelm. Flora 24¹: Beibl. 35. 1841.

Amblyanthera funiformis (Vell.) Muell.-Arg. in Mart. Fl. Bras. 6¹: 144. 1860.

Amblyanthera funiformis (Vell.) Muell.-Arg. α. *peduncularis* Muell.-Arg. loc. cit. 1860.

Amblyanthera funiformis (Vell.) Muell.-Arg. β. *brevipedunculata* Muell.-Arg. loc. cit. 1860.

Amblyanthera funiformis (Vell.) Muell.-Arg. γ. *microphylla* (Stadelm.) Muell.-Arg. loc. cit. *pl. 44.* 1860.

Echites Ganabarica Casaretto, ex Muell.-Arg. loc. cit. 1860, nom. nud. in synon.

Amblyanthera funiformis (Vell.) Muell.-Arg. δ. *arenaria* Muell.-Arg. loc. cit. 1860.

Echites arenaria Salzm. ex Muell.-Arg. loc. cit. 1860, nom. nud. in synon.

Mitozus exilis Miers, Apoc. So. Am. 218. *pl. 31.* 1878.

Mitozus Guanabaricus (Casar.) Miers, loc. cit. 1878, err. typ.

Mitozus funiformis (Vell.) Miers, loc. cit. 219. 1878.

Mitozus microphylla (Stadelm.) Miers, loc. cit. 1878.

Mandevilla funiformis (Vell.) K. Sch. var. *peduncularis* (Muell.-Arg.) Malme, Bihang till K. Sv. Vet. Akad. Handl. Afd. III. 24¹⁰: 23. 1899.

Suffruticose lianas; stems terete, relatively slender, glabrous; leaves opposite, petiolate, ovate to ovate-lanceolate, acuminate, broadly cordate, 2.5–6.0 cm. long, 1.0–4.5 cm. broad, firmly membranaceous, glabrous, glandular at the base of the midrib

above; petiole 0.5–1.0 cm. long; nodal appendages minute; inflorescence lateral, alternate, simply racemose, conspicuously longer than the subtending leaves, bearing 5–12 lax, yellowish flowers; pedicels 2.0–2.25 cm. long; bracts lanceolate, 0.1–0.2 cm. long, scarious; calyx-lobes broadly trigonal, acute, 0.1 cm. long, scarious, glabrous, the squamellae solitary, opposite, trigonal; corolla infundibuliform, glabrous without, the proper-tube straight, 1.0–1.5 cm. long, about 0.3 cm. in diameter at the base, the throat campanulate, 1.25–2.0 cm. long, about 1.0–1.5 cm. in diameter at the orifice, the lobes obliquely obovate, 1.5–2.0 cm. long, spreading; anthers obscurely auriculate, 0.7 cm. long; ovary ovoid, 0.3 cm. long, glabrous; nectaries 5, compressed-obovoid, 0.1 cm. long; follicles relatively slender, obscurely articulated, 10–15 cm. long, glabrous; seeds 0.7 cm. long, the brilliant tawny coma about 1.5 cm. long.

Brazil: parahyba: Parahiba, 1825, *Videnfis s. n.* (Bx); bahia: Maracas, Sept., 1906, *Ule 6988* (B, K); berge bei Calderão, Oct., 1906, *Ule 6988b* (B); Bahia, in sabulosis aridis, 1830, *Salzmann 318* (DC); minas geraes: Organ Mts., March, 1838, *Miers 4029* (BM); rio de janeiro: near Mage, March, 1837, *Gardner 538* (K); same locality, date lacking, *Miers 3436* (BM); Cabo Frio, 1815, *Pohl 15* (Bx); Mage, 1839, *Schott 5404* (Bx); Petropolis, 1910, *Luetzelburg s. n.* (B); Therezopolis, April, 1895, *Ule 3835* (B); Rio de Janeiro, date lacking, *Sellow 169* (K, NY); *Glaziou 8170* (B, C, K); *Glaziou 7754* (B, C); 1836, *Vauthier s. n.* (DC); são paulo: Rio Cubatão, in silva fluminali, Dec. 28, 1911, *Dusen 13708* (MBG, S, US); near Cubatão (at Rio-das-Pedras); in Mr. Smith's Citio and immediate vicinity, Dec. 8, 1826, *Burchell 3482* (Bx); in a walk from Santos to São Vicente, on the road, Oct. 23, 1826, *Burchell 3303* (Bx); Santos, date lacking, *Sellow 791* (B); Santos, in margine silv. litoralis, Febr. 10, 1875, *Mosen 3193* (S); parana: Volta Grande, in fruticetis, Nov. 5, 1908, *Dusen 6988* (S, US); Campo Grande, Serra do Mar, alt. 800 m., Nov., 1913, *Brade 6700* (B); Morretes opp., in silvula, July 16, 1911, *Dusen 11928* (S); data incomplete: *Sellow 217* (Bx); *Riedel 60* (B); *Riedel 61* (B, BB, G).

44. **Mandevilla Luetzelburgii** (Ross & Mgf.) Woodson, comb. nov.

Dipladenia Luetzelburgii Ross & Mgf. Notizblatt **9**: 396. *fig. 8.* 1925.

Suffruticose lianas; stems terete or very slightly compressed, relatively stout, softly puberulent when young, eventually glabrate or somewhat scabrous; leaves opposite, petiolate, ovate-elliptic, apex acuminate, base obtuse to obscurely cordate, 5–6 cm. long, 2.0–2.5 cm. broad, coriaceous or subcoriaceous, above

velutinous, glandular at the base of the midrib, beneath minutely and densely tomentulose; petiole 0.2–0.3 cm. long; nodal appendages 0.3–0.8 cm. long, unguiculate and coriaceous when fully developed; inflorescence lateral, alternate, simply racemose, about as long as the subtending leaves, bearing 8–10 rose-pink flowers; pedicels 0.5–0.7 cm. long; bracts ovate, 0.2–0.3 cm. long, scarious; calyx-lobes lanceolate, acuminate, 0.4–0.5 cm. long, scarious, sparsely puberulent-papillate, the squamellae in alternate groups of 4–6; corolla infundibuliform, puberulent-papillate without, the proper-tube straight, 1.25–1.5 cm. long, about 0.15 cm. in diameter at the base, the throat conical, 1.2–1.4 cm. long, about 1 cm. in diameter at the orifice, the lobes obliquely obovate, shortly acuminate, 2 cm. long, spreading; anthers auriculate, 0.8 cm. long; ovary oblongoid, 0.2 cm. long, glabrous; nectaries 5, compressed-oblongoid, very unequal, ⅛–½ as long as the ovary; follicles relatively stout, continuous, about 14 cm. long, glabrous; seeds 0.7 cm. long, the pale tawny coma about 1.25 cm. long.

BRAZIL: ESPIRITO SANTO: Serra Pintoba, urwald am Rio Doce, Febr., 1917, *Luetzelburg 7155* (B, M, TYPE, MBG, photograph and analytical drawings).

This species furnishes one of the most cogent arguments in favor of consolidating *Dipladenia* with *Mandevilla*, having been assigned to the former only because of its pronounced affinity with *D. Martiana* (Stadelm.) A. DC. regardless of the fact that the number of nectaries, two in the former instance and five in the latter, is the only expressible distinction between the two genera. This dilemma, strongly indicative of artificial generic criteria, is not exceptional, however. In *D. cuspidata* Rusby, the number of nectaries is evidently quite inconstant, varying from two to five among individuals from the same general locality and not infrequently under the same collector's number. The same situation obtains in *D. congesta* (HBK.) K. Sch. In *D. Achrestogyne* Woodson, the nectaries, numbering from two to four, are so inconspicuous that they must be dissected from between the tissues of the ovary and the receptacle to be observed. In *Echites Bogotensis* HBK. and *E. macrophylla* A. Zalhbr., of strongly pronounced affinity with the foregoing species, the nectaries have apparently degenerated without a trace.

Unless each newly found variation in number, or absence of the nectaries is to be seized upon as the basis for a new genus, it appears obvious that the generic importance of the number, or even presence of these vestigial organs must be minimized in generic segregation. Consequently the genus *Dipladenia* A. DC. has been consolidated with *Mandevilla* Lindl. to form an obviously natural aggregate.

45. **Mandevilla callista** Woodson, spec. nov.

Suffrutices volubiles ut dicitur ca. 3–8 m. alti; ramulis teretibus in sicco plus minusve angulosis compressis cortice flavo-brunneis sparse lenticellatis glabris; foliis oppositis longe petiolatis late ovatis apice abrupte angusteque acuminatis basi late cordatis 10–14 cm. longis 6–10 cm. latis membranaceis supra atroviridibus glabris nervo medio in longitudinem sparse sed conspicue glanduloso subtus pallidioribus venis venulisque minute puberulis; petiolo 5.0–6.5 cm. longo glabro; nodiis obscure 4-appendiculatis; inflorescentiis lateralibus alternatis racemosis simplicibus foliis aequantibus vel paululo superantibus floras ut dicitur plus minusve 30 speciosas suaveolentes prope apicem pedunculi gerentibus; pedicellis 1.5–2.0 cm. longis post maturitatem paulo accrescentibus; bracteis scariaceis minimis caducis; calycis laciniis ovato-deltoideis latissime obtusis 0.25 cm. longis scariaceis minute papillatis margine ciliolatis intus basi irregulariter multiglanduligeris; corollae infundibuliformis extus glabrae vel minutissime papillatae tubo proprio recto haud gibboso 1.5 cm. longo basi ca. 0.35 cm. diametro metiente prope apicem gradatim constricto albido faucibus anguste conicis 2 cm. longis ostio ca. 0.7–0.8 cm. diametro metiente albidis lobis ovato-dolabriformibus 2.5–3.0 cm. longis patulis basi albidis deinde roseis margine crenulatis aeneis; antheris auriculatis 0.8 cm. longis; ovario ovoideo ca. 0.175 cm. longo glabro; stigmate 0.2 cm. longo obscure apiculato; nectariis 5 compresse reniformibus carnosis plus minusve connatis ovario vix aequantibus; folliculis ignotis.

Suffruticose lianas said to attain a height of 3–8 m.; branches terete, more or less angular in desiccation, yellowish-brown, sparsely lenticellate, glabrous; leaves opposite, long-petiolate, broadly ovate, apex abruptly and narrowly acuminate, base

broadly cordate, 10–14 cm. long, 6–10 cm. broad, membranaceous, above dark green, glabrous, sparsely but conspicuously glandular along the midrib, beneath paler, minutely puberulent along the veins; petiole 5.0–6.5 cm. long; nodes obscurely 4-appendiculate; inflorescence lateral, alternate, simply racemose, about equalling or very slightly surpassing the leaves, bearing about 30 fragrant, showy flowers toward the end of the peduncle; pedicels 1.5–2.0 cm. long, slightly accrescent after maturity; bracts scarious, minute, caducous; calyx lobes ovate-deltoid, very broadly obtuse, 0.25 cm. long, scarious, minutely papillate without, margin ciliolate, the squamellae numerous, indefinitely distributed; corolla infundibuliform, glabrous without, the proper-tube straight, not gibbous, 1.5 cm. long, about 0.35 cm. in diameter at the base, gradually constricting toward the insertion of the stamens, white, the throat narrowly conical, 2 cm. long, about 0.7–0.8 cm. in diameter at the orifice, white or pale cream-colored, the lobes ovate-dolabriform, 2.5–3.0 cm. long, widely spreading, base white, "shading to a light rose, then to a dark rose, and the fringes are crenellated and a dark bronze;" anthers auriculate, 0.8 cm. long; ovary ovoid, about 0.175 cm. long, glabrous; stigma 0.2 cm. long, obscurely apiculate; nectaries 5, compressed-reniform, fleshy, more or less connate at the base, somewhat shorter than the ovary; follicles unknown.

COLOMBIA: BOYACA: El Humbo, 130 m. north of Bogota, forest fringes at brookside, alt. 3000 ft., March 25, 1933, *Lawrance 710* (FM, TYPE, MBG, photograph and analytical drawings).

This species is of particular significance, as it combines the floral characters of subgen. *Eumandevilla* sect. *Laxae* with the foliar character of subgen. *Exothostemon.* The aspect of the living plants has been carefully observed by the collector of the type specimen, from whom the description of the flower color has been quoted in the preceding paragraphs. Mr. Lawrance also reports "A very beautiful vine indeed. Each flower stem appears to carry thirty buds, more or less, and they bloom and fall singly." The Colombian popular name for the plant is reported to be "Bejuca," widely applied to other South American lianas of the Apocynaceae.

46. **Mandevilla Martiana** (Stadelm.) Woodson, comb. nov.

Suffruticose lianas; stems terete or very slightly compressed, relatively stout; leaves opposite, very shortly petiolate to subsessile, oblong to broadly oblong-elliptic, apex abruptly acuminate to obtuse, base broadly and rather obscurely cordate, 5–10 cm. long, 3.0–4.5 cm. broad, coriaceous, glandular at the base of the midrib above; nodal appendages 0.2–0.7 cm. long, coriaceous and reflexed when fully developed; inflorescence lateral, alternate, simply racemose, about twice as long as the subtending leaves, bearing 3–8 rosy-red flowers toward the distal half of the peduncle; pedicels 1.5–2.0 cm. long; bracts ovate-lanceolate, 0.5–0.7 cm. long, scarious; calyx-lobes narrowly ovate-lanceolate, long-acuminate, 0.7–1.0 cm. long, scarious, the squamellae in alternate groups of 8–10; corolla infundibuliform, glabrous without, the proper-tube straight, 2.0–2.75 cm. long, about 0.2 cm. in diameter at the base, the throat broadly conical to campanulate, 2.7–3.0 cm. long, about 1.75–2.0 cm. in diameter at the orifice, the lobes obliquely obovate, 3.5–4.0 cm. long, widely spreading; anthers auriculate, 0.7–0.8 cm. long; ovary oblongoid, about 0.2 cm. long, glabrous; stigma 0.15 cm. long, obscurely apiculate; nectaries 2, compressed-oblongoid, about half as long as the ovary; follicles unknown.

Var. **typica**

Echites Martiana Stadelm. Flora **24**[1]: Beibl. 31. 1844.

Dipladenia Martiana (Stadelm.) A. DC. in DC. Prodr. **8**: 485. 1844; Muell.-Arg. in Mart. Fl. Bras. **6**[1]: 127. 1860; K. Sch. in Engl. & Prantl, Nat. Pflanzenfam. **4**[2]: 169. 1895.

Dipladenia Martiana (Stadelm.) A. DC. *α. pubescens* Muell.-Arg. loc. cit. 128. 1860.

Micradenia hirsutula Miers, Apoc. So. Am. 160. 1878.

Micradenia Martiana (Stadelm.) Miers, loc. cit. 161. 1878.

Stems scabrous-hirtellous to glabrate; leaves bullate-scabrous above, puberulent-pilosulose beneath; all other essential characters as in the species.

BRAZIL: BAHIA: Itacolumi, Febr., 1839, *Martius 909* (M, Bx); ad Villa Novam da Mainho, April, year lacking, *Martius 300* (M, TYPE, MBG, photograph and analytical drawings); MINAS GERAES: Sabara, date lacking, *Claussen s. n.* (V).

Var. **glabra** (Muell.-Arg.) Woodson, comb. nov.

Dipladenia Martiana (Stadelm.) A. DC. β. *glabra* Muell.-Arg. loc. cit. 128. 1860.

Dipladenia acuminata Hook. Bot. Mag. III. 11: *pl. 4828.* 1855; Muell.-Arg. loc. cit. 129. 1860.

Plants essentially glabrous throughout; all other characters as in the species.

BRAZIL: MINAS GERAES: Serra da Piedade, Jan. 30, 1866, *Engle s. n.* (C, MBG, photograph); same locality and date, *Warming s. n.* (C); CULTIVATED: Herb. Royal Botanic Gardens, Kew (K, MBG, photograph).

It appears unavoidable to recognize these varieties because of the conspicuous diversity in their vegetative surfaces. Reasons for rejecting the genus *Dipladenia* will be found on page 699.

47. **Mandevilla crassinoda** (Gardn.) Woodson, comb. nov.

Echites crassinoda Gardn. ex Hook. Lond. Jour. Bot. 1: 544. 1842.

Dipladenia crassinoda (Gardn.) A. DC. in DC. Prodr. 8: 486. 1844; Muell.-Arg. in Mart. Fl. Bras. 6^1: 132. 1860.

Micradenia crassinoda (Gardn.) Miers, Apoc. So. Am. 158. 1878.

Suffruticose lianas; stems terete or somewhat compressed, relatively stout; leaves opposite, shortly petiolate, narrowly elliptic to linear, apex narrowly acute to acuminate, base attenuate, 5–8 cm. long, 1–3 cm. broad, coriaceous, glabrous, the upper surface glandular at the base of the midrib; petiole 0.5–1.0 cm. long; nodal appendages 0.1–0.3 cm. long, coriaceous, ovoid-reniform when fully developed; inflorescence lateral or subterminal, simply racemose, about half as long as the subtending leaves, bearing 2–3 white or cream-colored flowers toward the end of the peduncle; pedicels 1.0–1.25 cm. long; bracts ovate, 0.2–0.4 cm. long, scarious; calyx-lobes ovate, acute to acuminate, 0.4–0.5 cm. long, scarious, glabrous, the squamellae in alternate groups of 6–8; corolla infundibuliform, glabrous without, the proper-tube straight, 0.7–1.0 cm. long, about 0.2 cm. in diameter at the base, the throat narrowly conical to subtubular, 2.0–2.5 cm. long, about 0.8 cm. in diameter at the orifice, the lobes obliquely obovate, scarcely acuminate, 2.0–2.5 cm. long, widely

spreading; anthers auriculate, 0.9 cm. long; ovary oblongoid, about 0.2 cm. long, glabrous; stigma 0.2 cm. long, obscurely apiculate; nectaries 2, compressed-obovoid, about half as long as the ovary; follicles relatively slender, continuous, 10 cm. long, glabrous; seeds not examined.

Brazil: rio de janeiro: Mt. Corvocado, date lacking, *Gardner 250* (K, type, MBG, photograph); Forteresse, Pic de Santa Cruz, Aug. 7, 1872, *Glaziou 5943* (C, K, MBG, photograph and analytical drawings); exact locality and date lacking, *Glaziou 8171* (C).

In this species, as in several of its close relatives, there is not a sharp distinction between the suberect, and the typically twining habit characteristic of the majority of Mandevillas. As confusing as this variability may prove to be in the case of herbarium studies, it serves to accentuate the fallibility of habital distinctions when used as generic criteria in the Echitoideae of the western hemisphere.

48. **Mandevilla surinamensis** (Pulle) Woodson, comb. nov.

Dipladenia surinamensis Pulle, Rec. Trav. Bot. Néerl. **6**: 286. 1909.

Dipladenia upatae Woodson, Ann. Mo. Bot. Gard. **18**: 545. 1931.

Suffruticose or suffrutescent lianas; stems terete, relatively slender, occasionally sparsely and minutely pilosulose at the nodes, otherwise glabrous; leaves opposite, petiolate, oblong to obovate-elliptic, apex abruptly acuminate, base obtuse to obscurely cordate, 4–8 cm. long, 2.5–5.0 cm. broad, coriaceous or subcoriaceous, glabrous, the upper surface glandular at the base of the midrib; petiole 0.5–1.0 cm. long; nodal appendages 0.1–0.4 cm. long, coriaceous and reflexed when fully developed; inflorescence lateral, alternate, simply racemose, somewhat shorter than the subtending leaves, or about as long, bearing 3–7 white or cream-colored flowers toward the distal half of the peduncle; pedicels 0.5–0.7 cm. long; bracts minutely ovate, scarious; calyx-lobes lanceolate, acuminate, 0.4–0.5 cm. long, scarious, glabrous, the squamellae in alternate pairs; corolla infundibuliform, glabrous without, the proper-tube straight, 1.7–2.0 cm. long, about 0.15 cm. in diameter at the base, the throat subtubular, 1.5–1.8 cm. long, about 0.5 cm. in diameter

at the orifice, the lobes obliquely obovate, shortly acuminate, 2.5 cm. long, widely spreading; anthers auriculate, 0.7 cm. long; ovary oblongoid, about 0.3 cm. long, glabrous; stigma 0.25 cm. long, obscurely apiculate; nectaries 2, compressed-obovoid, about 1/8 as long as the ovary; follicles relatively stout, continuous, about 15 cm. long, glabrous; seeds unknown.

VENEZUELA: BOLIVAR: Upata, date lacking, *Osta 1014* (V, MBG, photograph and analytical drawings).

DUTCH GUIANA: fluv. Litanie, sup. prope Mount Knopaiamoi, Dec., 1903, *Versteeg 382* (U, TYPE, MBG, photograph and analytical drawings); fluv. Suriname, exact locality lacking, Jan. 10, 1908, *Tresling 407* (U).

49. **Mandevilla Moricandiana** (A. DC.) Woodson, comb. nov.

Echites obovata Nees, ex Steud. Nom. ed. 2. 1: 540. 1841.

Suffruticose or suffrutescent lianas, frequently suberect; stems terete or very slightly compressed, relatively slender; leaves opposite, petiolate, broadly obovate to orbicular-obovate, apex very abruptly acuminate to subcuspidate, base abruptly narrowed to the petiole, 1.5–2.5 cm. long, 1.25–2.5 cm. broad, coriaceous, upper surface glandular at the base of the midrib; petiole 0.2–0.3 cm. long; nodal appendages 0.1–0.15 cm. long, coriaceous when fully developed; inflorescence subterminal, simply racemose, about twice as long as the subtending leaves, bearing 3–5 yellowish or rose-colored flowers; pedicels 0.5 cm. long; bracts ovate-lanceolate, 0.2–0.3 cm. long; calyx-lobes lanceolate, acuminate, 0.3 cm. long, scarious, the squamellae in alternate groups of 4–6; corolla infundibuliform, glabrous without, the proper-tube straight, 1.5 cm. long, about 0.1 cm. in diameter at the base, the throat tubular or subtubular, 1.25–1.5 cm. long, about 0.5 cm. in diameter at the orifice, the lobes obliquely obovate, shortly acuminate, 1.25–1.5 cm. long, widely spreading; anthers auriculate, 0.8 cm. long, glabrous; stigma 0.2 cm. long, rather obscurely apiculate; nectaries 2, compressed-ovoid, slightly emarginate, nearly as long as the ovary; follicles slender, continuous, 10–12 cm. long, glabrous; seeds 0.75 cm. long, the pale tawny coma 1.5 cm. long.

Var. **typica**.

Dipladenia Moricandiana A. DC. in DC. Prodr. 8: 486. 1844; Muell.-Arg. in Mart. Fl. Bras. 6^1: 129. 1860.

Micradenia Moricandiana A. DC. ex Miers, Apoc. So. Am. 162. 1878.

Plants essentially glabrous throughout; stems occasionally minutely puberulent or pilosulose at the nodes; all other essential characters as in the species.

Brazil: bahia: Corral de Battuba, 1815, *Vindenfis 3131* (M); exact locality and date lacking, *Blanchet 1679* (M); Tocaja, date lacking, *Mikan s. n.* (V); rio grande do norte: near Natal, July, 1914, *Dawe 30* (K).

Var. **bahiensis** Woodson, var. nov., ab varietate typica foliis ramulisque velutino-pilosis differt.

Stems and leaves velutinous-pilose; all other essential characters as in the species.

Brazil: bahia: Serra do Sincora, Nov., 1906, *Ule 7121* (K, type, MBG, photograph and analytical drawings).

Were it not for the well-known variability of indument and leaf outline of the South American "Dipladenias," one might be persuaded to employ Ule's specimen as the basis for a distinct species. More ample material of *M. Moricandiana* vars. *typica* and *bahiensis* is greatly to be desired.

50. **Mandevilla eximia** (Hemsl.) Woodson, comb. nov.

Dipladenia eximia Hemsl. Gard. Chron. III. **14**: 120. 1893.

Suffruticose or suffrutescent lianas; stems terete, relatively slender, softly puberulent when young, eventually glabrate; leaves opposite, petiolate, suborbicular to orbicular-obovate, apex very abruptly acuminate to cuspidate, base rounded, 3–4 cm. long, 1.75–3.0 cm. broad, coriaceous, glabrous, the upper surface obscurely glandular at the base of the midrib; petiole 0.3–0.5 cm. long; nodal appendages rather inconspicuous, subcoriaceous and reflexed when fully developed; inflorescence lateral, alternate, simply racemose, about twice as long as the subtending leaves, bearing 4–6 rose-colored flowers; pedicels 0.5 cm. long; bracts ovate-lanceolate, acuminate, 0.2 cm. long, scarious; calyx-lobes narrowly lanceolate, acuminate, 0.4 cm. long, scarious, glabrous, the squamellae indefinitely distributed; corolla infundibuliform, glabrous without, the proper-tube straight, 1.25–1.5 cm. long, about 0.1 cm. in diameter at the base, the throat narrowly conical to subtubular, 1.5–1.75 cm. long,

about 0.5 cm. in diameter at the orifice, the lobes obliquely obovate, shortly acuminate, 2.5–3.0 cm. long, widely spreading; anthers auriculate, 0.7 cm. long; ovary ovoid-oblongoid, about 0.1 cm. long, glabrous; stigma 0.15 cm. long, obscurely apiculate; nectaries 2, compressed-oblongoid, nearly as long as the ovary; follicles unknown.

Unfortunately this species is known only from horticulture. It was originally imported from Brazil, probably from the vicinity of Santa Catharina, according to a letter to Sir J. D. Hooker from the importers, Sander & Co., introducers of several other tropical Apocynaceous plants for "stove" culture in the latter part of the past century, The plants thus imported were brought to blossom in 1893, and a specimen sent to Hooker. A specimen was also brought to flower at Kew in 1899, and an admirable plate drawn from it and published in the 'Botanical Magazine,' *pl. 7720.* 1899. Both specimens are preserved in the herbarium of the Royal Botanic Gardens, Kew.

M. eximia is very closely related to *M. Moricandiana* (A. DC.) Woodson, differing chiefly in the nearly orbicular leaves with rounded, not cuneate, bases, and the strictly lateral racemes. It is hoped that native collections will soon be forthcoming.

51. Mandevilla splendens (Hook.) Woodson, comb. nov.

Echites splendens Hook. f. Bot. Mag. N. S. **16**: *pl. 3976.* 1843.

Dipladenia splendens (Hook.) A. DC. in DC. Prodr. **8**: 676. 1844; Muell.-Arg. in Mart. Fl. Bras. **6**¹: 130. 1860.

Micradenia splendens (Hook.) A. DC. ex Miers, Apoc. So. Am. 163. 1878.

Suffruticose lianas; stems terete, relatively stout, puberulent-pilosulose, eventually becoming glabrate; leaves opposite, sessile or subsessile, broadly elliptic to oblong-elliptic, apex acuminate, base broadly and rather obscurely cordate, 12–20 cm. long, 6.0–7.5 cm. broad, membranaceous, above minutely pilose-hispidulous, glandular at the base of the midrib, beneath minutely puberulent-tomentulose; petiole 0.5 cm. long to virtually obsolete; nodal appendages dentiform-flagelliform, becoming somewhat coriaceous at maturity; inflorescence lateral, alternate, simply

racemose, about as long as the subtending leaves, bearing 3–5 showy, pink flowers; pedicels 1.25–1.5 cm. long; calyx-lobes ovate-lanceolate, acuminate, 0.5–0.75 cm. long, scarious, essentially glabrous, the squamellae in alternate groups of 6–8; corolla infundibuliform, glabrous without, the tube straight, 0.75–1.0 cm. long, about 0.15 cm. in diameter at the base, the throat broadly conical to campanulate, 2.0–2.5 cm. long, about 1.5–2.0 cm. in diameter at the orifice, the lobes obliquely obovate, shortly acuminate, 3–4 cm. long, widely spreading; anthers auriculate, 0.7 cm. long; ovary ovoid-oblongoid, about 0.15 cm. long, glabrous; stigma 0.2 cm. long, obscurely apiculate; nectaries 2(–4), compressed-obovoid, nearly as long as the ovary; follicles unknown.

BRAZIL: RIO DE JANEIRO: Organ Mts., date lacking, *Lobb s. n.* (K, TYPE, MBG, photograph and analytical drawings).

This species is one of the numerous Dipladenias introduced into cultivation by Sander & Co. in the past century. It is the only species ordinarily seen in cultivation at the present time.

52. **Mandevilla oblongifolia** Woodson, comb. nov.
Dipladenia oblongifolia Woodson, Ann. Mo. Bot. Gard. **18**: 544. 1931.

Suffruticose or suffrutescent lianas; stems relatively slender, terete, densely puberulent to glabrate; leaves opposite, petiolate, broadly oblong-elliptic, apex shortly acuminate, base rather obscurely cordate, 7–15 cm. long, 2–4 cm. broad, membranaceous, above minutely and densely puberulent to glabrate, glandular at the base of the midrib, beneath densely and minutely puberulent; petiole 2–3 cm. long; nodal appendages 0.2–0.4 cm. long, somewhat coriaceous when fully developed; inflorescence lateral, alternate, simply racemose, equalling or somewhat surpassing the subtending leaves, bearing 3–8 showy, white or cream-colored flowers; pedicels 0.5–1.0 cm. long; bracts scarious, minute; calyx-lobes narrowly ovate-lanceolate, acuminate, 0.5–0.7 cm. long, scarious, puberulent to glabrate, the squamellae in alternate groups of 4–8; corolla infundibuliform, glabrous without, the proper-tube straight, 1.5–1.75 cm. long, about 0.15 cm. in diameter at the base, the throat conical, 2.5 cm. long, about 1.5

cm. in diameter at the orifice, the lobes obliquely obovate, acuminate, 3.0–3.5 cm. long, widely spreading; anthers auriculate, 0.7 cm. long; ovary ovoid-oblongoid, about 0.1 cm. long, glabrous; stigma 0.2 cm. long, obscurely apiculate; nectaries 2, compressed-obovoid, somewhat shorter than the ovary; follicles unknown.

BOLIVIA: LA PAZ: La Florida, vec. de Yanocochi, alt. 1700 m., Dec. 6, 1906, *Buchtien 590* (US, TYPE, MBG, photograph and analytical drawings); Milluhuaya, alt. 1300 m., Dec, 1917, *Buchtien 4088* (G, US); same data, *Buchtien 4140* (G, US).

53. **Mandevilla glabra** (Rusby) Woodson, comb. nov.

Dipladenia glabra Rusby, Descr. So. Am. Pl. 88. 1920.

Suffruticose or suffrutescent lianas; stems terete, relatively slender, glabrous; leaves opposite, petiolate, oblong to oblong-elliptic, apex rather abruptly acuminate, base abruptly and rather obscurely cordate, 4–7 cm. long, 2–3 cm. broad, membranaceous, glabrous, glandular at the base of the midrib above; petiole 1.0–1.5 cm. long; nodal appendages flagelliform to flagelliform-dentiform; inflorescence lateral, alternate, simply racemose, about as long as the subtending leaves, bearing 2–5 showy, cream-colored or pinkish flowers; pedicels 1.0–1.5 cm. long; bracts minutely ovate, scarious; calyx-lobes ovate-lanceolate, acuminate, 0.3–0.4 cm. long, scarious, glabrous, the squamellae in alternate groups of 2–4; corolla infundibuliform, glabrous without, the proper-tube straight, 1.0–1.25 cm. long, about 0.1 cm. in diameter at the base, the throat rather narrowly conical, 1.25–1.5 cm. long, about 0.75–1.0 cm. in diameter at the orifice, lobes obliquely obovate, acuminate, 2.0–2.25 cm. long, widely spreading; anthers auriculate, 0.7 cm. long; ovary ovoid, about 0.15 cm. long; stigma 0.2 cm. long, obscurely apiculate; nectaries 2, compressed-ovoid, about half as long as the ovary; follicles relatively slender, obscurely articulated to subcontinuous, 10–14 cm. long; seeds unknown.

BOLIVIA: LA PAZ: Cotaña, am Illimani, alt. 2450 m., Nov., 1911, *Buchtien 3229* (G, NY, TYPE, US, MBG, photograph and analytical drawings); same locality, Dec. 9, 1876, *Stübel 56* (B); base of Mt. Illimani, Rio Palca valley, La Granja, alt. 2600 m., Dec., 1923, *Julio 128* (US); same locality, date lacking, *Julio 15* (US).

54. **Mandevilla superba** Herzog, in Fedde, Rep. Sp. Nov. 7: 65. 1909.

Essentially glabrous, suffruticose or suffrutescent lianas; stems terete, relatively slender; leaves opposite, shortly petiolate, oblong-elliptic, apex rather abruptly acuminate, base gradually narrowed and rather obscurely cordate, 4–6 cm. long, 1–3 cm. broad, membranaceous, glandular at the base of the midrib above; petiole 0.5–0.75 cm. long; nodal appendages 0.2–0.5 cm. long, reflexed-unguiculate, coriaceous when fully developed; raceme simple, lateral, alternate, somewhat longer than the subtending leaves, bearing 3–5 showy, cream-colored or pinkish flowers; pedicels 0.75 cm. long; bracts minutely ovate-lanceolate, scarious; calyx-lobes ovate-lanceolate, acuminate, 0.6 cm. long, the squamellae in alternate groups of 6–8; corolla infundibuliform, glabrous without, the proper-tube straight, 1.25–1.5 cm. long, about 0.15 cm. in diameter at the base, the throat broadly tubular, 3.5–4.0 cm. long, about 1.5 cm. in diameter at the orifice, the lobes obliquely obovate, shortly acuminate, 3.0–3.5 cm. long, widely spreading; anthers auriculate, 0.7 cm. long; ovary oblongoid, about 0.15 cm. long, glabrous; stigma 0.2 cm. long, obscurely apiculate; nectaries 2, compressed-ovoid, about ¼ as long as the ovary; follicles unknown.

Bolivia: potosi: in der Cactus- u. Dornbusch region zw. Pampa-Grande u. Pulquina, alt. 1700 m., Dec., 1907, *Herzog 742* (B, type, MBG, photograph and analytical drawings).

55. **Mandevilla angustifolia** (Malme) Woodson, comb. nov.

Dipladenia angustifolia Malme, Bull. Herb. Boiss. II. 4: 258. 1904.

Glabrous, suffruticose lianas; stems terete or slightly compressed, relatively stout; leaves opposite, shortly petiolate, linear to linear-lanceolate, infrequently oblong-elliptic, apex long-acuminate, base obtuse, not cordate, 6–15 cm. long, 0.5–4.0 cm. broad, membranaceous, glandular at the base of the midrib above; petiole 0.2–0.5 cm. long; nodal appendages reflexed-unguiculate to dentiform-flagelliform, coriaceous when fully developed; inflorescence lateral, alternate, simply racemose, usually somewhat shorter than the subtending leaves, bearing 3–15 showy, cream- or rose-colored flowers; pedicels 0.75–1.0 cm. long; bracts ovate-lanceolate, 0.1–0.3 cm. long, scarious;

calyx-lobes ovate-lanceolate, acuminate, 0.4–0.5 cm. long, scarious, the squamellae in alternate groups of 8–10, or indefinitely distributed; corolla infundibuliform, glabrous without, the proper-tube straight, 0.75–1.0 cm. long, about 0.2 cm. in diameter at the base, the throat broadly tubular, 4.0–4.25 cm. long, about 1 cm. in diameter at the orifice, the lobes obliquely obovate, shortly acuminate, 2.5–2.75 cm. long, widely spreading; anthers auriculate, 0.8 cm. long; ovary ovoid, about 0.15 cm. long, glabrous; stigma 0.2 cm. long, obscurely apiculate; nectaries 2, compressed-ovoid, nearly as long as the ovary; follicles relatively slender, continuous, 13–20 cm. long, glabrous; seeds 1 cm. long, the brilliant tawny coma 3 cm. long.

PARAGUAY: prope Concepcion, Aug., 1901, *Hassler 7204* (AA, BB, TYPE, G, K, B); Gran Chaco, exact locality lacking, date lacking, *Pride s. n.* (K).

ARGENTINA: TUCUMAN: Cerro del Campo, alt. 1000 m., Dec., 1928, *Venturi 7757* (MBG).

56. Mandevilla minor Woodson, spec. nov.

Suffrutices volubiles; ramulis teretibus gracilibus glabris; foliis oppositis breviter petiolatis linearibus apice acuminatis basi obtusis haud cordatis 3–10 cm. longis 0.25–0.75 cm. latis membranaceis omnino glabris nervo medio ventro basi pauciglanduligero; petiolo ca. 0.5 cm. longo; appendiculis interpetiolaribus 0.1–0.3 cm. longis maturitate coriaceis reflexis; inflorescentiis lateralibus alternatis racemosis simplicibus quam foliis paulo brevioribus floras speciosas albidas 3–5 prope partem superiorem pedunculi laxe gerentibus; pedicellis 0.5 cm. longis; bracteis ovatis scariaceis minimis; calycis laciniis ovato-lanceolatis acuminatis 0.2–0.3 cm. longis scariaceis glabris intus basi in marginibus 4–8-glanduligeris; corollae infundibuliformis extus omnino glabrae tubo proprio recto haud gibboso 0.3 cm. longo basi ca. 0.1 cm. diametro metiente faucibus tubulosis 1.75–2.0 cm. longis ostio ca. 0.5 cm. diametro metiente lobis oblique obovatis acutis 0.6–0.7 cm. longis patulis; antheris auriculatis 0.6 cm. longis; ovario ovoideo ca. 0.2 cm. longo glabro; stigmate 0.2 cm. longo obscure apiculato; nectariis 2 anguste ovoideis ovario subaequantibus; folliculis crassiusculis continuis 15–20 cm. longis glabris; seminibus ca. 1 cm. longis como aurantiaco ca. 2.5 cm. longo.

Glabrous, suffruticose lianas; stems terete, relatively slender; leaves opposite, shortly petiolate, linear, apex acuminate, base abruptly obtuse, not cordate, 3–10 cm. long, 0.25–0.75 cm. broad, membranaceous, sparsely glandular at the base of the midrib above; petiole 0.5 cm. long; nodal appendages 0.1–0.3 cm. long, reflexed-unguiculate, coriaceous when fully mature; inflorescence lateral, alternate, simply racemose, somewhat shorter than the subtending leaves, bearing 3–5 showy, white or cream-colored flowers; pedicels 0.5 cm. long; bracts minutely ovate, scarious; calyx-lobes ovate-lanceolate, acuminate, 0.2–0.3 cm. long, scarious, the squamellae in alternate groups of 4–8; corolla infundibuliform, glabrous without, the proper-tube straight, 0.3 cm. long, about 0.1 cm. in diameter at the base, the throat tubular, 1.75–2.0 cm. long, about 0.5 cm. in diameter at the orifice, the lobes obliquely obovate, acute, 0.6–0.7 cm. long, only slightly spreading; anthers auriculate, 0.6 cm. long; ovary ovoid, about 0.2 cm. long, glabrous; stigma 0.2 cm. long, obscurely apiculate; nectaries 2, compressed-ovoid, nearly as long as the ovary; follicles relatively stout, continuous, 15–20 cm. long, glabrous; seeds 1 cm. long, the brilliant tawny coma 2.5 cm. long.

ARGENTINA: FORMOSA: exact locality lacking, Jan., 1919, *Jørgensen 2605* (G, MBG, TYPE).

57. **Mandevilla cereola** Woodson, spec. nov.

Suffrutices volubiles; ramulis teretibus gracilibus glabris; foliis oppositis petiolatis anguste ellipticis vel elliptico-oblanceolatis apice acuminatis basi gradatim attenuatis haud cordatis, 6–10 cm. longis 2.0–3.5 cm. latis membranaceis omnino glabris supra eglandulosis; petiolo 1.5–2.0 cm. longo; nodiis ut videntur exappendiculatis; inflorescentiis lateralibus alternatis racemosis simplicibus quam foliis subtendentibus ca. dimidio brevioribus floras albidas 2–6 laxe gerentibus; pedicellis 0.8–1.0 cm. longis; bracteis ovatis scariaceis minimis; calycis laciniis ovato-lanceolatis acuminatis 0.4–0.5 cm. longis scariaceis glabris intus basi in marginibus 4–6-glanduligeris; corollae infundibuliformis extus glabrae tubo proprio recto 1.5–1.75 cm. longo basi ca. 0.2 cm. diametro metiente faucibus conicis 2.5–2.75 cm. longis ostio ca. 1.5 cm. diametro metiente lobis oblique obovatis acuminatis

2.75–3.0 cm. longis patulis; antheris auriculatis 1 cm. longis; ovario oblongoideo ca. 0.3 cm. longo glabro; stigmate 0.3 cm. longo obscure apiculato; nectariis 2 anguste ovoideis ovario ca. ter brevioribus; folliculis gracilibus continuis 12–15 cm. longis glabris; seminibus 0.8 cm. longis como dilute aurantiaco ca. 2 cm. longo.

Glabrous, suffruticose lianas; stems terete, relatively slender; leaves opposite, petiolate, narrowly elliptic to elliptic-oblanceolate, acuminate, base rather gradually attenuate, 6–10 cm. long, 2.0–3.5 cm. broad, membranaceous, eglandular above; petiole 1.5–2.0 cm. long; nodal appendages obsolete, at least above; racemes simple, lateral, alternate, about one-half as long as the subtending leaves, bearing 2–6 showy, white or cream-colored flowers; pedicels 0.8–1.0 cm. long; bracts minutely ovate, scarious; calyx-lobes ovate-lanceolate, acuminate, 0.4–0.5 cm. long, scarious, the squamellae in alternate groups of 4–6; corolla infundibuliform, glabrous without, the proper-tube straight, 1.5–1.75 cm. long, about 0.2 cm. in diameter at the base, the throat conical, 2.5–2.75 cm. long, about 1.5 cm. in diameter at the orifice, lobes obliquely obovate, acuminate, 2.75–3.0 cm. long, widely spreading; anthers auriculate, 1 cm. long; ovary oblongoid, 0.3 cm. long, glabrous; stigma 0.3 cm. long, obscurely apiculate; nectaries 2, compressed-ovoid, about one-third as long as the ovary; follicles relatively slender, continuous, 12–15 cm. long, glabrous; seeds 0.8 cm. long, the pale tawny coma 2 cm. long.

Ecuador: chimborazo: Huigra vicinity, Sept. 8, 1918, *Rose & Rose 22592* (US).

Bolivia: la paz: San Carlos, alt. 600 m., Jan. 29, 1927, *Buchtien 1737* (US, type, MBG, photograph and analytical drawings).

This species is easily distinguishable from *M. boliviensis*, with which it has been confused, by means of its conical corolla-throat and membranaceous foliage.

58. **Mandevilla fragrans** (Stadelm.) Woodson, comb. nov.

Echites fragrans Stadelm. Flora 24[1]: Beibl. 71. 1841.

Dipladenia fragrans (Stadelm.) A. DC. in DC. Prodr. 8: 483. 1844; Muell.-Arg. in Mart. Fl. Bras. 6[1]: 130. *pl. 39.* 1860.

Dipladenia fragrans (Stadelm.) A. DC. α. *oppositifolia* Muell.-Arg. loc. cit. 131. 1860.

Dipladenia fragrans (Stadelm.) A. DC. *β. ternatifolia* Muell.-Arg. loc. cit. 1860.

Dipladenia Riedelii Muell.-Arg. loc. cit. 1860.

Micradenia Riedelii (Muell.-Arg.) Miers, Apoc. So. Am. 160. 1878.

Micradenia fragrans (Stadelm.) Miers, loc. cit. 162. 1878.

Glabrous, suffruticose or suffrutescent lianas, occasionally suberect; stems relatively terete, stout; leaves opposite or rarely ternate, petiolate, broadly oblong to obovate-elliptic, apex abruptly acuminate to subcaudate-acuminate, base obtuse to rounded, 6–10 cm. long, 3–5 cm. broad, coriaceous, sparsely glandular at the base of the midrib above; petiole 1.25–2.0 cm. long; nodal appendages obsolete or extremely inconspicuous, at least above, occasionally conspicuous and coriaceous below; racemes simple, lateral, alternate, about equalling or somewhat longer than the subtending leaves, bearing 3–8 showy, white or cream-colored flowers; pedicels 1.25–1.5 cm. long; bracts minutely ovate, scarious; calyx-lobes ovate-lanceolate, long-acuminate, 0.5–0.6 cm. long, scarious, the squamellae in alternate groups of 6–8; corolla infundibuliform, glabrous without, the proper-tube straight, 1.0–1.25 cm. long, about 0.15 cm. in diameter at the base, the throat broadly conical-campanulate, 2.25–3.0 cm. long, about 1.5 cm. in diameter at the orifice, the lobes obliquely obovate, acuminate, 2–3 cm. long, suberect to widely spreading; anthers auriculate, 0.8 cm. long; ovary oblongoid, about 0.15 cm. long, glabrous; stigma 0.15 cm. long, obscurely apiculate; nectaries 2, compressed-obovoid, about one-third as long as the ovary; follicles unknown.

Brazil: minas geraes: exact locality and date lacking, *Pohl* (M, type, Bx, MBG, photograph and analytical drawings); rio de janeiro: exact locality lacking, Jan., 1897, *Ule 3829* (B, US); data incomplete: *Riedel s. n.* (B, MBG, photograph); *Glaziou 11187* (C); *Glaziou 7755* (C); *Glaziou 4086* (C).

The type specimen of *Dipladenia Riedelii* Muell.-Arg. (*Riedel s. n.* in Hb. Berol.) differs from that of *Echites fragrans* Stadelm. (*Pohl s. n.* in Hb. Monac.) in a somewhat smaller corolla with slightly shorter, more erect lobes. This character appears to intergrade among other specimens, and consequently has not been considered of specific, or even of varietal importance.

59. Mandevilla permixta Woodson, spec. nov.

Suffrutices volubiles; ramulis teretibus crassiusculis glabris; foliis oppositis petiolatis late ellipticis vel obovato-ellipticis apice abrupte breviterque caudato-acuminatis basi late obtusis vel rotundatis 4–7 cm. longis 2.5–4.0 cm. latis coriaceis omnino glabris nervo medio ventro basi pauciglanduligero; petiolo 1.0–1.25 cm. longo; nodiis superioribus exappendiculatis inferioribus appendiculas conspicuas coriaceasque munitis; inflorescentiis lateralibus alternatis racemosis simplicibus floras albidas 3–8 laxe gerentibus; pedicellis 1.25–1.5 cm. longis; bracteis ovatis scariaceis minimis; calycis laciniis ovatis acutis vel late acuminatis 0.2–0.3 cm. longis scariaceis glabris intus basi in marginibus 4–6-glanduligeris; corollae infundibuliformis extus glabrae tubo proprio recto 1.5–1.75 cm. longo basi ca. 0.15 cm. diametro metiente faucibus late conicis 2.0–2.25 cm. longis ostio 1.5–1.75 cm. diametro metiente lobis oblique obovatis breviter acuminatis 2.5–3.0 cm. longis patulis; antheris auriculatis 0.7 cm. longis; ovario oblongoideo ca. 0.2 cm. longo glabro; stigmate 0.2 cm. longo obscure apiculato; nectariis 2, anguste obovoideis ovario ca. ter brevioribus; folliculis ignotis.

Glabrous, suffruticose or suffrutescent lianas; stems relatively stout, terete; leaves opposite, petiolate, the blade broadly elliptic to obovate-elliptic, abruptly and shortly caudate-acuminate, base broadly obtuse to rounded, 4–7 cm. long, 2.5–4.0 cm. broad, coriaceous, sparsely glandular at the base of the midrib above; petiole 1.0–1.25 cm. long; stipular appendages obsolete or extremely inconspicuous above, conspicuous and coriaceous below; racemes simple, lateral, alternate, the peduncle somewhat shorter than the subtending leaves, bearing 3–8 white or cream-colored flowers; pedicels 1.25–1.5 cm. long; bracts minutely ovate, caducous; calyx-lobes ovate, acute to broadly acuminate, 0.2–0.3 cm. long, scarious, the squamellae in alternate groups of 4–6; corolla infundibuliform, glabrous without, the proper-tube cylindrical, straight, 1.5–1.75 cm. long, about 0.15 cm. in diameter at the base, the throat rather broadly conical, 2.0–2.25 cm. long, about 1.5–1.75 cm. in diameter at the orifice, the lobes obliquely obovate, shortly acuminate, 2.5–3.0 cm. long, widely spreading; anthers auriculate, 0.7 cm. long; ovary oblongoid, about 0.2 cm.

long, glabrous; stigma 0.2 cm. long, obscurely apiculate; nectaries 2, compressed-obovoid, about one-third as long as the ovary; follicles unknown.

Brazil: Bahia: exact locality and date lacking, *Blanchet 3960* (C, M, MBG, type, K).

This species differs from *M. fragrans*, with which it has been confused, in the strictly conical corolla-throat, which is nearly as long as the proper-tube, and in the much shorter calyx-lobes. With few exceptions the construction of the corolla and the relative length of calyx-lobes are conspicuous and apparently reliable specific criteria throughout the genera of American Echitoideae.

60. **Mandevilla boliviensis** (Hook. f.) Woodson, comb. nov.
Dipladenia boliviensis Hook. f. Bot. Mag. III. **25**: *pl. 5783.* 1869.

Glabrous, suffruticose lianas; stems terete, relatively stout; leaves opposite, petiolate, elliptic to obovate-elliptic, apex caudate-acuminate, base obtuse, 6–10 cm. long, 2.0–4.25 cm. broad, coriaceous, sparsely glandular at the base of the midrib above, rarely eglandular; petiole 1.0–1.75 cm. long; nodal appendages obsolete or extremely inconspicuous, at least above; racemes simple, lateral, alternate, somewhat shorter than the subtending leaves, bearing 3–7 showy, white flowers; pedicels 1.5–2.0 cm. long; bracts minutely ovate, scarious; calyx-lobes ovate-lanceolate, acuminate, 0.4–0.5 cm. long, scarious, the squamellae in alternate groups of 4–6; corolla infundibuliform, glabrous without, the proper-tube straight, 1.5–1.75 cm. long, about 0.15 cm. in diameter at the base, the throat narrowly conical, 2.25–2.5 cm. long, about 0.75–1.0 cm. in diameter at the orifice, the lobes obliquely obovate, shortly acuminate, 2–3 cm. long, widely spreading; anthers auriculate, 1 cm. long; ovary oblongoid, 0.2 cm. long, glabrous; stigma 0.2 cm. long, obscurely apiculate; nectaries 2, compressed-obovoid, about one-half as long as the ovary; follicles unknown.

Ecuador: Tungurahua: Rio Pastaza, between Baños and Mera, alt. 4000 ft., 1924, *Tate 669* (US).

Bolivia: exact locality and date lacking, *Pearce 708* (K, type, MBG, photograph and analytical drawings).

61. Mandevilla bella (Pittier) Woodson, comb. nov.
Dipladenia bella Pittier, Jour. Wash. Acad. Sci. **21:** 141. 1931.

Glabrous, suffruticose lianas; stems terete, relatively stout; leaves opposite, petiolate, obovate-elliptic, apex abruptly acuminate, base cuneate, rather narrowly obtuse to acute, 8–11 cm. long, 4–5 cm. broad, coriaceous, sparsely glandular at the base of the midrib above; petiole 1.5–2.0 cm. long; nodal appendages obsolete or extremely inconspicuous above; racemes simple, lateral, alternate, about half as long as the subtending leaves, bearing 3–7 showy, white flowers; pedicels 2 cm. long; bracts minutely ovate, scarious; calyx-lobes broadly ovate, acute, 0.2–0.3 cm. long, scarious, the squamellae in alternate groups of 4–6; corolla infundibuliform, glabrous without, the proper-tube straight, 1.5–1.75 cm. long, about 0.2 cm. in diameter at the base, the throat narrowly conical or tubular-conical, 2.0–2.25 cm. long, about 1 cm. in diameter at the orifice, the lobes obliquely obovate, scarcely acuminate, 3.5–4.0 cm. long, widely spreading; anthers auriculate, 1 cm. long; ovary oblongoid, gradually produced into the style, 0.3 cm. long, glabrous; stigma 0.25 cm. long, shortly apiculate; nectaries 2, obovoid-reniform, about one-third as long as the ovary; follicles unknown.

VENEZUELA: DISTRITO FEDERAL: hacienda Puerto la Cruz, Coastal Range, alt. 0.2300 m., Aug. 28–Sept. 4, 1918, *Pittier 8108* (US, ISOTYPE, MBG, photograph and analytical drawings); ANZOATEGUI: on humid rocks, Ocumare Valley, Aragua, Oct. 12, 1927, *Pittier 12556* (US).

62. Mandevilla Muelleri Woodson, nom. nov.
Dipladenia scabra Muell.-Arg. in Mart. Fl. Bras. **6**[1]**:** 128. 1860, not acc. to Miers, loc. cit. 155. 1878.

Suffruticose lianas (occasionally suberect?); stems terete or slightly compressed, relatively stout, minutely hirtellous when young, eventually glabrate; leaves opposite, shortly petiolate, broadly oblong to obovate-oblong, apex abruptly acuminate, base rounded and obscurely cordate, 5–9 cm. long, 2.5–4.0 cm. broad, coriaceous, either surface minutely hirtellous when young, becoming scabrous; petiole 0.25–0.5 cm. long; nodal appendages obsolete or extremely inconspicuous, at least above; racemes simple, lateral, alternate, somewhat longer than the subtending

leaves, bearing 6–8 white or cream-colored (or pinkish?) flowers; pedicels 1 cm. long; bracts ovate-lanceolate, 0.3–0.4 cm. long, scarious; calyx-lobes lanceolate, long-acuminate, 0.8–1.0 cm. long, scarious, glabrous, the squamellae in alternate groups of 4–6; corolla infundibuliform, glabrous without, the proper-tube straight, 1.5 cm. long, about 0.15 cm. in diameter at the base, the throat tubular-conical, 1.5–1.75 cm. long, about 0.75 cm. in diameter at the orifice, the lobes obliquely obovate, shortly acuminate, 2.0–2.25 cm. long, widely spreading; anthers auriculate, 0.75 cm. long; ovary ovoid, about 0.1 cm. long, glabrous; stigma 0.2 cm. long, obscurely apiculate; nectaries 2, ovoid-reniform, about half as long as the ovary; follicles unknown.

Brazil: data incomplete: *Sellow 34* (B, type, MBG, photograph and analytical drawings).

This change in name is necessitated by the preexistence of *M. scabra* (R. & S.) K. Sch.

63. Mandevilla lucida Woodson, spec. nov.

Suffrutices volubiles; ramulis teretibus vel paulo compressis crassiusculis, glabris; foliis oppositis petiolatis late oblongo-ellipticis abrupte acuminatis basi rotundatis vel late obscureque cordatis 6–9 cm. longis 3.5–5.0 cm. latis coriaceis glabris supra nitidis nervo medio basi pauciglanduligero; petiolo 1.0–1.5 cm. longo; nodiis superioribus ut videntur exappendiculatis; inflorescentiis lateralibus alternatis racemosis simplicibus quam foliis paulo brevioribus floras albidas 3–8 gerentibus; pedicellis 0.8–1.0 cm. longis; bracteis ovatis scariaceis minimis; calycis laciniis oblongis acuminatis 0.6–0.8 cm. longis scariaceis vel paulo foliaceis glabris intus basi in marginibus 4–6-glanduligeris; corollae infundibuliformis extus glabrae tubo proprio recto 0.8–1.0 cm. longo basi ca. 0.15 cm. diametro metiente faucibus tubulo-conicis 0.8–1.0 cm. longis ostio ca. 0.4 cm. diametro metiente lobis oblique obovatis acuminatis 1.3–1.5 cm. longis patulis; antheris auriculatis 0.6 cm. longis; ovario oblongoideo ca. 0.2 cm. longo glabro; stigmate 0.2 cm. longo obscure apiculato; nectariis 2 ovoideo-reniformibus ovario ca dimidio brevioribus; folliculis crassiusculis continuis, divaricatis, 6–7 cm. longis glabris; seminibus 0.8 cm. longis como aurantiaco ca. 2 cm. longo.

Glabrous, suffruticose lianas; stems terete or slightly compressed, relatively stout; leaves opposite, petiolate, broadly oblong-elliptic, apex abruptly acuminate, base rounded to broadly and rather obscurely cordate, 6–9 cm. long, 3.5–5.0 cm. broad, coriaceous, upper surface strikingly nitidulous, glandular at the base of the midrib; petiole 1.0–1.5 cm. long; nodal appendages obsolete or extremely inconspicuous above; racemes simple, lateral, alternate, somewhat shorter than the subtending leaves, bearing 3–8 showy, white flowers; pedicels 0.8–1.0 cm. long; bracts minutely ovate, scarious; calyx-lobes oblong, acuminate, 0.6–0.8 cm. long, subfoliaceous, the squamellae in alternate groups of 4–6; corolla infundibuliform, glabrous without, the proper-tube straight, 0.8–1.0 cm. long, about 0.15 cm. in diameter at the base, the throat tubular conical, 0.8–1.0 cm. long, about 0.4 cm. in diameter at the orifice, the lobes obliquely obovate, acuminate, 1.3–1.5 cm. long, widely spreading; anthers auriculate, 0.6 cm. long; ovary oblongoid, about 0.2 cm. long, glabrous; stigma 0.2 cm. long, obscurely apiculate; nectaries 2, ovoid-reniform, compressed, about half as long as the ovary; follicles relatively short and stout, essentially continuous, somewhat divaricate, 6–7 cm. long, glabrous; seeds 0.8 cm. long, the tawny coma 2 cm. long.

BRAZIL: RIO DE JANEIRO: environs, Febr., 1882, *Glaziou 12955* (C, K, TYPE, MBG, photograph and analytical drawings).

Because of its relatively small corolla, subfoliaceous calyx-lobes, and thickly coriaceous, lustrous foliage, this species is very conspicuous among its closely neighboring congeners. Additional collections are greatly to be desired.

64. **Mandevilla Sellowii** (Muell.-Arg.) Woodson, comb. nov.

Dipladenia Sellowii Muell.-Arg. in Mart. Fl. Bras. 6^1: 128. 1860.

Micradenia Sellowii (Muell.-Arg.) Miers, Apoc. So. Am. 161. 1878.

Glabrous, suffruticose lianas, rarely suberect; leaves opposite, petiolate, rather narrowly elliptic, apex acuminate to subcaudate-acuminate, base broadly acute, 5–8 cm. long, 2–3 cm. broad, coriaceous, dark green, sparsely glandular at the base of

the midrib above; petiole 1.25–1.5 cm. long; nodal appendages obsolete or extremely inconspicuous, at least above; racemes simple, lateral, alternate, somewhat longer than the subtending leaves, bearing 3–5 showy, rose-colored flowers; pedicels 1 cm. long; bracts minutely ovate, scarious; calyx-lobes ovate-lanceolate, acuminate, 0.7–0.9 cm. long, scarious, the squamellae in alternate groups of 4–6; corolla infundibuliform, glabrous without, the proper-tube straight, 2.5–3.0 cm. long, about 0.15 cm. in diameter at the base, the throat rather broadly conical, 2.5–2.75 cm. long, about 2 cm. in diameter at the orifice, the lobes obliquely obovate, shortly acuminate, 2.5–3.0 cm. long, widely spreading; anthers auriculate, 1 cm. long; ovary oblongoid, about 0.25 cm. long, glabrous; stigma 0.3 cm. long, obscurely apiculate; nectaries 2, ovoid-reniform, about half as long as the ovary; mature follicles unknown.

BRAZIL: MINAS GERAES: exact locality and date lacking, *Sellow s. n.* (Bx, TYPE, Camb., MBG, photograph and analytical drawings); RIO DE JANEIRO: exact locality and date lacking, *Glaziou 8803* (C, K); DATA INCOMPLETE: *Glaziou 15215* (C).

65. **Mandevilla Sanderi** (Hemsl.) Woodson, comb. nov.

Dipladenia Sanderi Hemsl. Gard. Chron. III. **20**: 652. 1896.

Glabrous, suffruticose lianas; stems terete, relatively stout; leaves opposite, petiolate, broadly oblong-elliptic, apex shortly acuminate, base rounded to very obscurely cordate, 4.5–6.0 cm. long, 2.5–3.0 cm. broad, coriaceous, pale and nitidulous, sparsely glandular above; petiole 0.75–1.0 cm. long; nodal appendages obsolete or extremely inconspicuous, at least above; racemes simple, lateral, alternate, about as long as the subtending leaves, bearing 3–5 showy, rose-pink flowers; pedicels 1.25 cm. long; bracts minutely ovate, scarious; calyx-lobes ovate-lanceolate, acuminate, 0.75 cm. long, scarious, the squamellae in alternate groups of 4–6; corolla infundibuliform, glabrous without, the proper-tube straight, 2.25–2.5 cm. long, about 0.2 cm. in diameter at the base, the throat broadly conical, 2 cm. long, about 2 cm. in diameter at the orifice, the lobes obliquely obovate, scarcely acuminate, 3.0–3.25 cm. long, widely spreading; anthers unknown; ovary oblongoid, gradually produced into the style, 0.25 cm. long; stigma unknown; nectaries 2, ovoid-reniform, about half as long as the ovary; follicles unknown.

M. Sanderi is known at present only from a single specimen of a Brazilian plant imported by Sander & Co. of St. Albans, England. The type specimen, which has been examined in the course of this study, is deposited in the herbarium of the Royal Botanic Gardens, Kew, and a photograph has been incorporated in the herbarium of the Missouri Botanical Garden. Although closely related to *M. Sellowii*, the very distinct foliage appears to justify the retention of *M. Sanderi* as a species.

66. **Mandevilla immaculata** Woodson, spec. nov.

Suffrutices volubiles; ramulis teretibus gracilibus glabris; foliis oppositis petiolatis late ellipticis apice abrupte acuminatis vel subcaudato-acuminatis basi obtusis 4–6 cm. longis 2–3 cm. latis membranaceis omnino glabris supra eglandulosis; petiolo 1.0–1.5 cm. longo; nodiis superioribus exappendiculatis; inflorescentiis lateralibus alternatis racemosis simplicibus foliis aequantibus vel paulo superantibus floras speciosas roseas 2–3 gerentibus; pedicellis 1.0–1.25 cm. longis; bracteis ovatis scariaceis minimis; calycis laciniis ovato-lanceolatis acuminatis 0.7–0.8 cm. longis scariaceis glabris intus basi in marginibus 2–4-glanduligeris; corollae infundibuliformis extus glabrae tubo proprio recto 1.8–2.0 cm. longo basi ca. 0.2 cm. diametro metiente faucibus campanulatis 1.5–2.0 cm. longis ostio ca. 1.25–1.5 cm. diametro metiente lobis oblique obovatis acuminatis 2.5–3.0 cm. longis patulis; antheris auriculatis 1 cm. longis; ovario oblongoideo ca. 0.3 cm. longo glabro; stigmate 0.2 cm. longo obscure apiculato; nectariis 2 anguste oblongoideis ovario ca. dimidio brevioribus; folliculis ignotis.

Glabrous, suffruticose or suffrutescent lianas; stems terete, relatively slender; leaves opposite, petiolate, broadly elliptic, apex abruptly acuminate to subcaudate-acuminate, base obtuse, 4–6 cm. long, 2–3 cm. broad, firmly membranaceous, eglandular above; petiole 1.0–1.5 cm. long; nodal appendages obsolete or extremely inconspicuous, at least above; racemes simple, lateral, alternate, equalling or somewhat surpassing the subtending leaves, bearing 2–3 showy, rose-colored flowers; pedicels 1.0–1.25 cm. long; bracts minutely ovate, scarious; calyx-lobes ovate-lanceolate, acuminate, 0.7–0.8 cm. long, scarious, the squamellae in

alternate groups of 2–4; corolla infundibuliform, glabrous without, the proper-tube straight, 1.8–2.0 cm. long, about 0.2 cm. in diameter at the base, the throat campanulate, 1.5–2.0 cm. long, about 1.25–1.5 cm. in diameter at the orifice, the lobes obliquely obovate, shortly acuminate, 2.5–3.0 cm. long, widely spreading; anthers auriculate, 1 cm. long; ovary oblongoid, about 0.3 cm. long; stigma 0.2 cm. long, rather obscurely apiculate; nectaries 2, compressed-oblongoid, about half as long as the ovary; follicles unknown.

BRAZIL: SÃO PAULO: exact locality lacking, 1861–62, *Weir 462* (K); PARANA: Banhado, in silva primaeva, Dec. 30, 1908, *Dusen 7409* (G, MBG, TYPE); Banhado, in graminosis subhumidis, Dec. 13, 1911, *Dusen s. n.* (US).

This species is instantly distinguishable from *M. Sellowii*, with which it has been confused, by its broadly campanulate corolla-throat, and broader, membranaceous, eglandular foliage.

67. **Mandevilla urophylla** (Hook. f.) Woodson, comb. nov.

Dipladenia urophylla Hook. f. Bot. Mag. III. 4: *pl. 4414*. 1848; Muell.-Arg. in Mart. Fl. Bras. 6^1: 131. 1860.

Micradenia urophylla (Hook. f.) Miers, Apoc. So. Am. 161. 1878.

Glabrous, suffruticose or suffrutescent lianas; stems terete, relatively slender; leaves opposite, petiolate, rather broadly elliptic to ovate or obovate-elliptic, apex abruptly caudate-acuminate, base obtuse to rounded, 6–10 cm. long, 2.5–4.5 cm. broad, subcoriaceous, somewhat nitidulous and sparsely glandular at the base of the midrib above; petiole 1.5–2.25 cm. long; nodal appendages obsolete or extremely inconspicuous; racemes simple, lateral, alternate, somewhat shorter than the subtending leaves, bearing 4–7 showy, cream-colored, rose-flushed flowers; pedicels 1.0–1.25 cm. long; bracts minutely ovate-lanceolate, scarious; calyx-lobes ovate-lanceolate, acute, 0.4–0.5 cm. long, the squamellae in alternate groups of 4–6; corolla infundibuliform, glabrous without, the proper tube straight, 0.6–0.8 cm. long, about 0.25 cm. in diameter at the base, the throat rather narrowly campanulate, 2.0–2.25 cm. long, about 1.25 cm. in diameter at the orifice, the lobes obovate-reniform, obscurely acuminate, 1.25–1.5 cm. long, pink, widely spreading; anthers auriculate, 0.6

cm. long; ovary oblongoid, 0.3 cm. long, glabrous; stigma 0.2 cm. long, shortly apiculate; nectaries 2, compressed-obovoid, about one-third as long as the ovary; follicles relatively slender, continuous, 10–15 cm. long, glabrous, seeds 0.5 cm. long, the pale-tawny coma 2 cm. long.

BRAZIL: RIO DE JANEIRO: "environs," April, 1883, *Glaziou 14061* (C, K); near Rio de Janeiro, Nov., 1869, *Glaziou 11190* (C, K); "Rio," date lacking, *Glaziou 19627* (C, K); Organ Mts. between Soberbo and Guapy, alt. 100–900 m., Dec. 18, 1928, *L. B. Smith 1529* (G); PARANA: in vicinia Morretes, ad ripam fluminis Rio Marumby, alt. 40 m., Jan. 23, 1914, *Dusen 14384* (G, MBG, US); Serra do Mar, Volta Grande, in silva primaeva, alt. 400 m., July 31, 1911, *Dusen 11988* (G, MBG); Cadeado, in rupibus fere perpendicularibus nec non in declivibus graminosis, Dec. 13, 1909, *Dusen 8681* (AA, MBG); Volta Grande, ad marginem silvae primaevae, Nov. 19, 1911, *Dusen 13430* (US); exact locality lacking, Febr. 10, 1904, *Dusen 3564* (US).

68. **Mandevilla venulosa** (Muell.-Arg.) Woodson, comb. nov.
Dipladenia venulosa Muell.-Arg. in Mart. Fl. Bras. 6^1: 126. 1860; Miers, Apoc. So. Am. 156. 1878.

Essentially glabrous, erect or suberect, suffrutescent undershrubs, rarely twining; stems terete or slightly compressed, relatively stout; leaves opposite, sessile or subsessile, broadly ovate-elliptic, apex obtuse to very abruptly and shortly acuminate, base broadly cordate and somewhat amplexicaul, 7–12 cm. long, 4.0–7.5 cm. broad, coriaceous, nitidulous and sparsely glandular at the base of the midrib above; nodal appendages obsolete or extremely inconspicuous; racemes simple, lateral or subterminal, alternate, about as long as the subtending leaves, bearing 3–5 showy, cream-colored or pinkish flowers; pedicels 1.0–1.25 cm. long; bracts ovate-lanceolate, 0.3–0.6 cm. long, scarious; calyx-lobes lanceolate, acuminate, 1.0–1.25 cm. long, scarious, the squamellae in irregular groups or indefinitely distributed; corolla infundibuliform, glabrous without, the proper-tube 1.0–1.25 cm. long, about 0.25 cm. in diameter at the base, the throat rather narrowly campanulate, 2.25 cm. long, about 1.25 cm. in diameter at the orifice, the lobes obliquely obovate, shortly acuminate, 3.5–4.0 cm. long, widely spreading; anthers auriculate, 0.9 cm. long, sparsely pilosulose dorsally; ovary oblongoid, about 0.3 cm. long, glabrous; stigma 0.3 cm. long, conspicuously apiculate; nectaries 2, reniform, about 0.5

cm. long; follicles relatively stout, essentially continuous, 12–15 cm. long, glabrous; seeds 0.5 cm. long, the brilliant tawny coma 1.5 cm. long.

Brazil: minas geraes: Caldas, Oct., 1854, *Lindberg 194a* (Bx, type, MBG, photograph and analytical drawings); exact locality lacking, Dec. 10, 1873, *Mosen 947* (C); exact locality lacking, Oct. 16, 1861, *Regnell 875* (Bx, M, US); "dans les savanes," date lacking, *Claussen s. n.* (V).

69. **Mandevilla atroviolacea** (Stadelm.) Woodson, comb. nov.

Echites atroviolacea Stadelm. Flora 24[1]: Beibl. 75. 1841.

Echites atropurpurea Lindl. in Paxt. Mag. Bot. 9: 199. 1842.

Dipladenia atroviolacea (Stadelm.) A. DC. in DC. Prodr. 8: 484. 1844; Muell.-Arg. in Mart. Fl. Bras. 6[1]: 127. 1860.

Dipladenia atropurpurea (Lindl.) A. DC. loc. cit. 486. 1844.

Dipladenia atroviolacea (Stadelm.) A. DC. α. *latifolia* Muell.-Arg. loc. cit. 1860.

Dipladenia atroviolacea (Stadelm.) A. DC. α. *latifolia* Muell.-Arg. *1. scandens* Muell.-Arg. loc. cit. 1860.

Dipladenia atroviolacea (Stadelm.) A. DC. α. *latifolia* Muell.-Arg. *2. suberecta* Muell.-Arg. loc. cit. 1860.

Dipladenia atroviolacea (Stadelm.) A. DC. β. *cuneata* Muell.-Arg. loc. cit. 1860.

Dipladenia atroviolacea (Stadelm.) A. DC. γ.? *cordata* Muell.-Arg. loc. cit. 1860.

Micradenia atroviolacea (Stadelm.) Miers, Apoc. So. Am. 159. 1878.

Glabrous, suffrutescent lianas, occasionally suberect; stems terete, relatively slender; leaves opposite, petiolate, broadly elliptic to obovate-elliptic, apex caudate-acuminate, base obtuse to rounded, 2.0–4.5 cm. long, 1.75–2.5 cm. broad, firmly membranaceous to subcoriaceous, eglandular at the base of the midrib above; petiole 0.75–1.25 cm. long; nodal appendages obsolete or extremely inconspicuous; racemes simple, lateral to subterminal, alternate, equalling or somewhat surpassing the subtending leaves, bearing 2–5 showy, dark reddish purple flowers; pedicels 1.0–1.25 cm. long; bracts minutely ovate, scarious; calyx-lobes ovate- to oblong-lanceolate, acuminate, 0.4–0.6 cm. long, scarious, the squamellae nearly quadrate, geminate; corolla infundibuliform,

glabrous without, the proper-tube straight, 1.25–2.0 cm. long, about 0.3 cm. in diameter at the base, the throat rather narrowly campanulate, 2–3 cm. long, about 1.25–1.5 cm. in diameter at the orifice, the lobes obliquely obovate to obovate-reniform, obscurely acuminate, 1.5–1.75 cm. long, nearly erect or slightly spreading; anthers auriculate, 0.8 cm. long; ovary oblongoid, about 0.2 cm. long, glabrous; stigma 0.25 cm. long, rather obscurely apiculate; nectaries 2, compressed-ovoid, about half as long as the ovary; follicles relatively slender, continuous, 15–20 cm. long; seeds 0.5 cm. long, the pale tawny coma 2 cm. long.

BRAZIL: MINAS GERAES: in monte Serra da Piedade, Febr. 2, 1866, *Engle s. n.* (C); exact locality lacking, 1862, *Netto* (Bx, MP); RIO DE JANEIRO: ad urbem in rupibus cacuminis Poci do Papagaio montium Tijuca, Nov. 29, 1928, *Ducke 21809* (US); haut du Pico do Papagaio, Oct. 12, 1867, *Glaziou 2099* (Bx); on the summit of the Pedra Bonita, date lacking, *Gardner 249* (Camb.); exact locality lacking, 1867, *Glaziou 635* (Bx); exact locality and date lacking, *Glaziou s. n.* (Bx); SÃO PAULO: in campis herbidis udis ad Mogy das Cruces et alibi in silvaticis, Dec., year lacking, *Martius 506* (M, TYPE, MBG, photograph); PARANA: Jaguariahyva, ad marg. silvae primaevae, alt. 740 m., March 25, 1916, *Dusen 18012* (G, MBG); exact locality lacking, Dec. 22, 1903, *Dusen s. n.* (US); DATA INCOMPLETE: *Sellow 1656* (Bx); *Sellow s. n.* (Bx); *Glaziou 3054* (C); *Glaziou 2091* (C).

70. Mandevilla pendula (Ule) Woodson, comb. nov.

Dipladenia pendula Ule, Ber. Deut. Bot. Ges. **14**: 234. 1896.

Glabrous, suffrutescent lianas, occasionally suberect; stems terete, relatively slender; leaves opposite, petiolate, narrowly elliptic to obovate-elliptic, apex shortly subcaudate-acuminate, base obtuse, 3.5–7.5 cm. long, 1.5–3.25 cm. broad, firmly membranaceous to subcoriaceous, somewhat nitidulous, eglandular at the base of the midrib above; petiole 1–2 cm. long; nodal appendages obsolete or extremely inconspicuous; racemes simple, lateral to subterminal, alternate, equalling or somewhat surpassing the length of the subtending leaves, bearing 3–7 showy, cream and reddish purple flowers; pedicels 2.0–2.25 cm. long; bracts minutely ovate, scarious; calyx-lobes lanceolate, acuminate, 0.75–1.0 cm. long, scarious, the squamellae depressed-quadrate, geminate; corolla infundibuliform, glabrous without, the proper-tube straight, 1.25 cm. long, about 0.2 cm. in diameter at the base, reddish purple, the throat tubular-campanulate, 2–3 cm. long, about 1.0–1.25 cm. in diameter at the orifice, reddish purple

at the base, the lobes obliquely oblong-ovate to narrowly oblong-elliptic, acute, 1.25–2.0 cm. long, cream-colored, erect or essentially so; anthers auriculate, 0.7 cm. long; ovary ovoid-oblongoid, about 0.2 cm. long, glabrous; stigma 0.15 cm. long, obscurely apiculate; nectaries 2, compressed-ovoid, about half as long as the ovary; follicles unknown.

BRAZIL: MINAS GERAES: Retiro, Serra dos Orgãos, Oct., 1916, *Luetzelburg 6953* (M); RIO DE JANEIRO: in regione Itatiaya, alt. 1400–2000 m., Sept., 1901, *Wettstein & Shiffner s. n.* (C, V); "environs," April, 1882, *Glaziou 14062* (C, K); "Rio," date lacking, *Glaziou 17135* (C, K); exact locality and date lacking, *Glaziou 6638* (K); SÃO PAULO: Alto do Serra, Nov. 3, 1917, *Hoehne 834* (M).

71. Mandevilla sancta (Stadelm.) Woodson, comb. nov.

Echites sancta Stadelm. Flora 24^1: Beibl. 59. 1841.

Dipladenia sancta (Stadelm.) A. DC. in DC. Prodr. **8**: 484. 1844; Muell.-Arg. in Mart. Fl. Bras. 6^1: 126. 1860; Miers, Apoc. So. Am. 154. 1878.

Glabrous, suffruticose undershrubs; stems terete, relatively stout; leaves opposite, sessile to very shortly petiolate, broadly ovate-oblong to suborbicular, apex abruptly and shortly acute to acuminate, rarely obtuse or retuse, base rounded to obscurely cordate, occasionally somewhat amplexicaul, 3–5 cm. long, 2.25–5 cm. broad, coriaceous, sparsely glandular at the base of the midrib above; nodal appendages obsolete or very inconspicuous; racemes subterminal, simple, usually somewhat shorter than the subtending leaves, bearing 8–12 showy, rose-red flowers; pedicels 0.75–1.0 cm. long; bracts minutely ovate, scarious; calyx-lobes ovate to ovate-lanceolate, acuminate, 0.5–0.75 cm. long, scarious, the squamellae in alternate groups of 2–6; corolla infundibuliform, glabrous without, the proper-tube 1.5–2.0 cm. long, about 0.2 cm. in diameter at the base, the throat narrowly campanulate, 2.0–2.25 cm. long, about 1.5 cm. in diameter at the orifice, the lobes obliquely obovate, very shortly acuminate, 2.0–2.25 cm. long, widely spreading; anthers auriculate, 0.8–1.0 cm. long; ovary ovoid-oblongoid, about 0.2 cm. long, glabrous; stigma 0.2–0.3 cm. long, rather obscurely apiculate; nectaries 2, compressed-obovoid, about half as long as the ovary; follicles relatively slender, continuous, 10–12 cm. long, glabrous; seeds 0.6 cm. long, the pale tawny coma 1.75 cm. long.

BRAZIL: BAHIA: Monte Santo, Apr., year lacking, *Martius 307* (M, TYPE, MBG, photograph and analytical drawings); auf Felsen bei Maracas, Sept., 1906, *Ule 7080* (K, MBG, photograph and analytical drawings).

The two specimens cited do not agree in all particulars. That of Martius has somewhat larger, more nearly orbicular leaves which are cordate and practically sessile, while that of Ule is characterized by leaves which are rounded, but scarcely cordate at the base and are borne upon short (0.1–0.2 cm.) petioles. Future evidence may prove them to be distinct.

72. Mandevilla illustris (Vell.) Woodson, comb. nov.

Erect, suffrutescent herbs from a napiform, tuberous root; stems terete or slightly compressed, relatively stout; leaves opposite or rarely ternate, sessile or subsessile, broadly oblong-elliptic to ovate or obovate, occasionally suborbicular, apex abruptly and shortly acute to acuminate or occasionally somewhat obtuse or retuse, base obtuse or rounded, frequently rather obscurely cordate, 4–10 cm. long, 3.0–8.5 cm. broad, firmly membranaceous to chartaceous; nodal appendages obsolete or extremely inconspicuous; racemes terminal, occasionally subterminal, simple, equalling or somewhat surpassing the subtending leaves, bearing 2–9 showy, deep pink or rosy-red flowers; pedicels 1.0–1.5 cm. long; bracts lanceolate, acuminate, 0.3–0.5 cm. long, scarious; calyx-lobes lanceolate to ovate-lanceolate, acuminate, 0.75–1.25 cm. long, scarious, the squamellae in alternate groups of 2; corolla infundibuliform, the proper-tube straight, 1.25–1.75 cm. long, about 0.2 cm. in diameter at the base, the throat narrowly conical, 1.5–2.5 cm. long, about 0.75–1.0 cm. in diameter at the orifice, the lobes obliquely obovate, shortly acuminate, 2.5–3.0 cm. long, widely spreading; anthers auriculate, 0.7–0.8 cm. long; ovary ovoid, about 0.2 cm. long, glabrous; stigma 0.2 cm. long, shortly apiculate; nectaries 2, compressed-ovoid, about half as long as the ovary; follicles relatively long and stout, continuous, 20–30 cm. long, glabrous; seeds 0.75 cm. long, the brilliant tawny coma about 2 cm. long.

Var. **typica.**

Echites illustris Vell. Fl. Flum. 114. 1830; Icon. **3**: *pl. 49.* 1827; Stadelm. Flora 24^1: Beibl. 69. 1841.

Echites venenosa Stadelm. loc. cit. 66. 1841; A. DC. in DC. Prodr. **8**: 470. 1844.

Dipladenia illustris (Vell.) A. DC. loc. cit. 483. 1844; Miers, Apoc. So. Am. 153. 1878.

Dipladenia Gardneriana A. DC. loc. cit. 1844; Miers, loc. cit. 155. 1878.

Dipladenia Gardneriana A. DC. *β. grandiflora* A. DC. loc. cit. 1844.

Echites Rosa-campestris Endl. in Harting. Parad. Vindob. **1**: *pl. 51.* 1844–47.

Dipladenia Rosa-campestris (Endl.) Lem. Fl. Serres & Jard. I. **3**[8]: 256. *pl. 4.* 1847; Miers, loc. cit. 156. 1878.

Dipladenia illustris (Vell.) Muell.-Arg. in Mart. Fl. Bras. **6**[1]: 125. 1860, sphalm.

Dipladenia illustris (Vell.) Muell.-Arg. *α. tomentosa* Muell.-Arg. loc. cit. 1860.

Dipladenia illustris (Vell.) Muell.-Arg. *α. tomentosa* Muell.-Arg. *a. rotundifolia* Muell.-Arg. loc. cit. 1860.

Dipladenia illustris (Vell.) Muell.-Arg. *α. tomentosa* Muell.-Arg. *a. rotundifolia* Muell.-Arg. *1. hirsuta* Muell.-Arg. loc. cit. 1860.

Dipladenia illustris (A. DC.) Muell.-Arg. *α. tomentosa* Muell.-Arg. *a. rotundifolia* Muell.-Arg. *2. pubescens* Muell.-Arg. loc. cit. 1860.

Dipladenia illustris (A. DC.) Muell.-Arg. *α. tomentosa* Muell.-Arg. *b. elliptica* Muell.-Arg. loc. cit. 1860.

Dipladenia illustris (A. DC.) Muell.-Arg. *α. tomentosa* Muell.-Arg. *b. elliptica* Muell.-Arg. *1. hirsuta* Muell.-Arg. loc. cit. 1860.

Dipladenia illustris (A. DC.) Muell.-Arg. *α. tomentosa* Muell.-Arg. *b. elliptica* Muell.-Arg. *2. pubescens* Muell.-Arg. loc. cit. 1860.

Dipladenia illustris (A. DC.) Muell.-Arg. *α. tomentosa* Muell.-Arg. *c. oblongifolia* Muell.-Arg. loc. cit. 1860.

Dipladenia illustris (Vell.) A. DC. f. *pilosa* Hoehne, Comm. Linh. Telegr. Estrat. Matto Grosso, Annexo 5, Bot. **6**: 85. 1915.

Stems, foliage, and calyx-lobes tomentose to pilose; all other characters similar to the species.

BRAZIL: MINAS GERAES: Caldas, in campis, Oct. 22, 1854, *Lindberg 194* (Bx); in campis prope Ypanema, March, year lacking, *Martius s. n.* (M); congonhas do Campo, date lacking, *Martius 293* (Bx, MBG, photograph); Caldas, 1859–60, *Regnell 280* (Bx, C, M, S, US); Barbacena, date lacking, *Pohl s. n.* (Bx, MBG, photograph); Lagoa Santa, Oct. 28, 1863, *Warming s. n.* (C); exact locality lacking, 1845, *Widgren 370* (Bx, G, US); Aug.–April, 1840, *Claussen 99, 100* (Bx); *Claussen 331* (C, MP); *Glaziou 17134* (C); BAHIA: Igreja Velha, date lacking, *Blanchet 3382* (C); Sincora et Lages, Nov., year lacking, *Martius s. n.* (M); GOYAZ: Ponte Alta, Sept. 27, 1894, *Glaziou 21724* (Bx, C, MP, US); exact locality lacking, *Gardner 3311* (NY); PARANA: Jaguariahyva, in campo cerrado, alt. 760 m., Nov. 27, 1914, *Dusen 15913* (MBG); same locality, Oct. 31, 1910, *Dusen 10693* (G, MBG, US); DATA INCOMPLETE: *Glaziou 15217* (C, Bx); *Glaziou s. n.* (Bx); *Burchell 63961* (Bx); *Sellow 1658* (Bx); *Pohl s. n.* (Bx, M); *Riedel s. n.* (BB, Bx, G, M); *Warming s. n.* (C); *Bang s. n.* (Bx).

Var. **glabra** (Muell.-Arg.) Woodson, comb. nov.

Echites alexicaca Stadelm. Flora 24^1: Beibl. 68. 1841.

Dipladenia alexicaca (Stadelm.) A. DC. in DC. Prodr. **8**: 484. 1844; Miers, Apoc. So. Am. 156. 1878.

Dipladenia androsaemifolia A. DC. loc. cit. 1844; Miers, loc. cit. 1878.

Dipladenia nobilis Morr. Ann. Soc. Gand **3**: 331. *pl. 152.* 1847; Muell.-Arg. in Mart. Fl. Bras. 6^1: 130. 1860.

Dipladenia illustris (Vell.) Muell.-Arg. β. *glabra* Muell.-Arg. loc. cit. 125. *pl. 38.* 1860.

Chariomma nobilis (Morr.) Miers, loc. cit. 113. 1878.

Dipladenia illustris (Vell.) A. DC. f. *glabra* (Muell.-Arg.) Hoehne, Comm. Linh. Telegr. Estrat. Matto Grosso, Annexo 5, Bot. **6**: 85. 1915.

Plants glabrous throughout, or essentially so; in all other characters similar to the species.

BRAZIL: MARANHÃO: deep sandy slope, 25 leagues s. w. of Barro do Corda, Oct. 31, 1924, *Shaw s. n.* (US); BAHIA: in campis altis ad Rio de Contas, date lacking, *Martius 299* (M, MBG, photograph); Igreja Velha, date lacking, *Blanchet 3382* in part (Bx, C, M, MBG, NY); MINAS GERAES: Lagoa Santa, date lacking, *Engle s. n.* (C); exact locality lacking, date lacking, *Martius s. n.* (M).

It appears highly impractical to subdivide this species into many varieties upon the basis of such variable characters as leaf outline and size, nature and amount of pubescence, number of flowers, etc.

73. Mandevilla cuspidata (Rusby) Woodson, comb. nov.

Dipladenia cuspidata Rusby, Bull. N. Y. Bot. Gard. **4**: 410. 1907.

Dipladenia mollis Rusby, loc. cit. **8**: 114. 1912.

Dipladenia Buchtienii Rusby, Descr. So. Am. Pl. 87. 1920.

Dipladenia piladenia Rusby, loc. cit. 1920.

Dipladenia tetradenia Rusby, loc. cit. 88. 1920.

Odontadenia cuspidata Rusby, loc. cit. 89. 1920.

Dipladenia rotundifolia Rusby, Mem. N. Y. Bot. Gard. **7**: 326. 1927.

Erect, suffrutescent herbs; stems terete, relatively stout, densely puberulent-pilosulose to glabrate or glabrous; leaves opposite, sessile to subsessile, suborbicular to ovate or broadly oblong-elliptic, apex very abruptly and shortly acute to acuminate, occasionally obtuse or somewhat retuse, base rounded and usually rather broadly and obscurely cordate, 5–10 cm. long, 2–7 cm. broad, firmly membranaceous, finely and densely puberulent-pilose to glabrate, very rarely essentially glabrous, sparsely glandular at the base of the midrib above; nodal appendages obsolete or extremely inconspicuous; racemes terminal, simple, usually greatly surpassing the subtending leaves, bearing 2–8 showy, cream-colored or pink-flushed flowers; pedicels 1–2 cm. long; bracts lanceolate to ovate-lanceolate, acuminate, 0.3–0.5 cm. long, scarious; calyx-lobes lanceolate to ovate-lanceolate, acuminate, 0.5–1.0 cm. long, scarious, the squamellae in alternate groups of 2–4; corolla infundibuliform, the proper-tube straight, 1.25–2.0 cm. long, about 0.25 cm. in diameter at the base, the throat narrowly conical to subtubular, 2.0–3.25 cm. long, about 0.75–1.5 cm. in diameter at the orifice, the lobes obliquely obovate, acuminate, 2.5–3.25 cm. long, widely spreading; anthers auriculate, 0.7–0.8 cm. long; ovary ovoid-oblongoid, 0.1–0.2 cm. long, glabrous; stigma 0.2 cm. long, obscurely apiculate; nectaries 2–5, more or less dissimilar in size and shape, usually lobed or emarginate when fewer than 5, about half as long as the ovary; follicles unknown.

Peru: cuzco: Valle de Santa Ana, Pumachaca, alt. 1400 m., Oct., 1931, *Herrera 3282* (US).

Bolivia: la paz: Polo-Polo bei Coroico, alt. 1100 m., Oct.–Nov., 1912, *Buchtien 3903* (NY, US, MBG, photograph); Milluhuaya, alt. 1800 m., Dec., 1917, *Buchtien*

4032 (US); Ixiamas, alt. 800 ft., Dec. 16, 1921, *Cardenas 1144* (NY, MBG, photograph); Reis, alt. 1500 ft., June, 1886, *Rusby 2694* (NY, MBG, photograph); "Yungas," 1890, *Bang 249* (BB, G, K, M, MBG, NY, US).

This species is almost bewildering in the great variability of virtually all characters, including several of the most important systematically. The variation in number and constitution of the gynoecial nectaries of *M. cuspidata* provides one of the most cogent arguments against the validity of the genus *Dipladenia*, as they appear to be constant not even for occasional individual plants. The size and shape of the corolla is also very inconstant.

M. cuspidata is extremely closely related to *M. illustris*, with which it may scarcely be separated in several instances. Beside the key characters upon which they are separated, and of which that of geography must be admittedly one of the most trustworthy superficially, the dimensions and constitution of the corolla appear significant. The proper-tube of *M. cuspidata* as a rule is somewhat shorter in proportion to the length of the throat than in *M. illustris*. Although such a character is difficult to use as a criterion in a key, due to occasional intergradation, its validity may be affirmatively tested upon a number of specimens.

74. **Mandevilla velutina** (Mart.) Woodson, comb. nov.

Erect, suffrutescent herbs, from a napiform, tuberous root; stems terete, relatively stout; leaves opposite, shortly petiolate to subsessile, ovate or obovate to ovate- or obovate-oblong, occasionally narrowly oblong to oblong-oblanceolate, apex abruptly acuminate to obtuse or occasionally somewhat retuse, base rather abruptly rounded and usually obscurely cordate, occasionally obtuse to rounded, 3.5–12.0 cm. long, 1.5–6.0 cm. broad, firmly membranaceous, sparsely glandular at the base of the midrib above, occasionally eglandular; petiole 0.1–0.3 cm. long or essentially obsolete; nodal appendages obsolete or extremely inconspicuous; racemes terminal, simple, usually about twice as long as the subtending leaves, bearing 2–10 showy, pink flowers; pedicels 1.0–1.5 cm. long; bracts lanceolate to ovate-lanceolate, acuminate, 0.2–0.5 cm. long, scarious; calyx-lobes lanceolate to ovate-lanceolate, acuminate, 0.6–1.25 cm. long, scarious, the squamellae dentiform, in alternate groups of 4–6; corolla infundibuliform, the proper-tube straight, 1.0–1.25 cm. long, about 0.25

cm. in diameter at the base, the throat broadly tubular, slightly narrowing toward the orifice, 2.75–5.0 cm. long, about 0.75–1.25 cm. in diameter at the orifice, the lobes obliquely obovate, shortly acuminate, 2.0–3.25 cm. long, very slightly spreading; anthers auriculate, 0.7–0.9 cm. long; ovary ovoid-oblongoid, 0.15–0.2 cm. long, glabrous; stigma 0.2 cm. long, rather obscurely apiculate; nectaries 2, compressed-obovoid, truncate or slightly lobed or emarginate, about half as long as the ovary; follicles relatively long and slender, continuous, 20–30 cm. long; seeds not examined.

Var. **typica.**

Echites velutina Mart. ex Stadelm. Flora **24**[1]: Beibl. 72. 1841.

Dipladenia velutina (Mart.) A. DC. in DC. Prodr. **8**: 483. 1844; Miers, Apoc. So. Am. 154. 1878.

Dipladenia gentianoides Muell.-Arg. *α. velutina* (Mart.) Muell.-Arg. in Mart. Fl. Bras. **6**[1]: 124. 1860.

Dipladenia gentianoides Muell.-Arg. *α. velutina* (Mart.) Muell.-Arg. *α.* longiloba* Muell.-Arg. loc. cit. 1860.

Stems, foliage, and calyx tomentose-velutinous or pilose to glabrate; all other essential characters as in the species.

BRAZIL: MINAS GERAES: Lagoa Santa, Dec. 13, 1863, *Engle s. n.* (C); exact locality lacking, Nov., 1867, *Regnell 287* (C, S, US); Aug.–Apr., 1840, *Claussen 103* (Bx); exact locality and date lacking, *Widgren 371* (Bx, C, M, S, US); RIO DE JANEIRO: exact locality and date lacking, *Raben s. n.* (C); SÃO PAULO: Taubate, Nov. 23, year lacking, *Lund s. n.* (C); in campis herbidis udiusculis ad Mogy das Cruzes, Dec., year lacking, *Martius 503* (M, TYPE, MBG, photograph and analytical drawings); PARANA: Desirio Ribas, Turma, in campo, alt. 800 m., Oct. 20, 1914, *Dusen 1350a* (MBG); exact locality lacking, Dec. 7, 1903, *Dusen 14749* (US); DATA INCOMPLETE: *Raben s. n.* (Bx); *Sellow 4801* (Bx); *Glaziou s. n.* (US); *Riedel s. n.* (G, M).

Var. **glabra** (Muell.-Arg.) Woodson, comb. nov.

Echites Pohliana Stadelm. Flora **24**[1]: Beibl. 73. 1841; A. DC. in DC. Prodr. **8**: 470. 1844.

Echites Pohliana Stadelm. var. *α. angustifolia* Stadelm. loc. cit. 1841.

Echites Pohliana Stadelm. var. *β. latifolia* Stadelm. loc. cit. 75. 1841; A. DC. loc. cit. 1844.

Dipladenia gentianoides A. DC. loc. cit. 484. 1844; Miers, Apoc. So. Am. 157. 1878.

Anisolobus Pohlianus (Stadelm.) Miers, loc. cit. 171. 1878.
Dipladenia gentianoides Muell.-Arg. *β. glabra* Muell.-Arg. in Mart. Fl. Bras. 6[1]: 124. *pl. 37. fig. 2.* 1860.
Dipladenia gentianoides Muell.-Arg. *β. glabra* Muell.-Arg. *1. obovata* Muell.-Arg. loc. cit. 1860.
Dipladenia gentianoides Muell.-Arg. *β. glabra* Muell.-Arg. *2. ovata* Muell.-Arg. loc. cit. 1860.
Dipladenia gentianoides Muell.-Arg. *β. glabra* Muell.-Arg. *β.* longiloba* Muell.-Arg. loc. cit. 1860.
Dipladenia gentianoides A. DC. var. *Pohliana* (Stadelm.) Malme, Bihang till K. Sv. Vet. Akad. Handl. Afd. III, 24[10]: 20. 1899.
Dipladenia Pohliana (Stadelm.) Handel-Mzt. Denkschr. K. K. Akad. Wissensch. Wien 79[2]: 11. 1910.

Plants glabrous throughout, or essentially so; all other essential characters as in the species.

BRAZIL: BAHIA: Sincora, Nov., year lacking, *Martius 292* (M, MBG photograph and analytical drawings); MINAS GERAES: Lagoa Santa, Jan. 2, 1864, *Engle s. n.* (C); exact locality and date lacking, *Claussen 344* (C, MP); RIO DE JANEIRO: Mage, Nov., 1833, *Lund s. n.* (C); SÃO PAULO: Bututan, Nov. 17, 1917, *Hoehne 896* (G); PARANA: chapado de Tamandua, Nov., 1913, *Luetzelburg 5000* (M); Serrinha, in campo, Nov. 27, 1911, *Dusen 13454* (US); Jaguariahyva, in campo, Oct. 27, 1910, *Dusen 10694* (US); MATTO GROSSO: Cuyaba, 1834, *Manso 398* (Bx); DATA INCOMPLETE: *Riedel s. n.* (BB, G); *Pohl s. n.* (Bx, MBG, photograph).

PARAGUAY: in regione cursus superioris fluminis Y-aca, Dec., 1900, *Hassler 6658* (BB); some data *Hassler 6816* (BB); in regione fluminis Corrientes, Sept., year lacking, *Hassler 4499* (BB); Cordillera de Altos, Oct., 1902, *Fiebrig 310* (AA, M); Caaguazu sur les collines incultes, Nov. 7, 1874, *Balansa 1354* (BB).

M. velutina, *M. illustris*, and *M. cuspidata* apparently offer an interesting example of parallel variation caused by similar ecological conditions.

75. Mandevilla linearis (Muell.-Arg.) Woodson, comb. nov.
Dipladenia linearis Muell.-Arg. in Mart. Fl. Bras. 6[1]: 123. 1860; Miers, Apoc. So. Am. 157. 1878.

Glabrous, suffrutescent herbs; stems terete, relatively slender; leaves opposite or occasionally ternate, shortly petiolate to subsessile, linear, 5–10 cm. long, 0.2–0.3 cm. broad, firmly membranaceous, eglandular; petiole 0.2–0.3 cm. long; nodal appendages obsolete; racemes simple, terminal, much surpassing

the subtending leaves, bearing 2–6 showy, pinkish flowers; pedicels 1.0–1.25 cm. long; bracts ovate-lanceolate, acuminate, 0.3–0.6 cm. long, scarious; calyx-lobes lanceolate to ovate-lanceolate, acuminate, scarious, 0.5–1.0 cm. long, the squamellae in alternate groups of 4–6; corolla infundibuliform, glabrous without, the proper-tube straight, 1.0–1.25 cm. long, about 0.25 cm. in diameter at the base, the throat broadly tubular, 3.5–4.0 cm. long, about 0.75–1.25 cm. in diameter at the orifice, the lobes obliquely obovate, shortly acuminate, 2.0–2.5 cm. long, spreading; anthers auriculate, 0.7–0.8 cm. long; ovary ovoid-oblongoid, about 0.15 cm. long, glabrous; stigma 0.2 cm. long, rather obscurely apiculate; nectaries 2–3, compressed-obovoid, truncate or somewhat lobed, about half as long as the ovary; follicles unknown.

BRAZIL: MINAS GERAES: exact locality uncertain, 1845, *Widgren 63* (Bx, TYPE, C, US, MBG, photograph and analytical drawings); SÃO PAULO: exact locality lacking, *Sellow s. n.* (M); PARANA: Turma, in paludosis, Jan. 22, 1910, *Dusen 9098* (G, US); prope Ponta Grossa, in uliginosis ad flum. Rio Tibagy, alt. 800 m., Jan. 17, 1909, *Dusen 7542* (MBG).

PARAGUAY: in regione cursus superioris fluminis Jejui-guazu, Dec., year lacking, *Hassler 5733* (BB).

This species perhaps is only a variety of *M. velutina.*

76. Mandevilla coccinea (Hook. & Arn.) Woodson, comb. nov.

Echites coccinea Hook. & Arn. in Hook. Jour. Bot. **1**: 286. 1834; A. DC. in DC. Prodr. **8**: 476. 1844.

Echites (?) xanthostoma Stadelm. Flora **24**[1]: Beibl. 55. 1841; A. DC. loc. cit. 468. 1844.

Dipladenia Saponariae A. DC. loc. cit. 485. 1844.

Dipladenia xanthostoma (Stadelm.) Muell.-Arg. in Mart. Fl. Bras. **6**[1]: 123. 1860; K. Sch. in Engl. & Prantl, Nat. Pflanzenfam. **4**[2]: 169. 1895.

Dipladenia xanthostoma (Stadelm.) Muell.-Arg. *a. major* Muell.-Arg. loc. cit. 1860.

Dipladenia xanthostoma (Stadelm.) Muell.-Arg. *b. minor* Muell.-Arg. loc. cit. 1860.

Rhodocalyx coccineus (Hook. & Arn.) Miers, Apoc. So. Am. 141. 1878.

Rhodocalyx ovatus Miers, loc. cit. 1878.
Echites coccinea Hook. & Arn. var. *β. ovata* Hook. & Arn. ex Miers, loc. cit. 1878, sphalm in synon.
Rhodocalyx Tweedianus Miers, loc. cit. 142. 1878.
Dipladenia saponaria A. DC. ex Miers, loc. cit. 157. 1878, sphalm.
Temnadenia xanthostoma (Stadelm.) Miers, loc. cit. 212. 1878.

Glabrous, erect, suffrutescent herbs from a napiform, tuberous root; stems terete, relatively slender; leaves opposite, shortly petiolate to subsessile, lanceolate to ovate or oblong-elliptic, rarely suborbicular, apex acute to acuminate, rarely obtuse, base rounded to broadly obtuse, 3–8 cm. long, 0.75–3.5 cm. long, firmly membranaceous, eglandular or essentially so; petiole 0.2–0.3 cm. long or virtually obsolete; nodal appendages obsolete; racemes simple, terminal, greatly surpassing the subtending leaves, bearing 5–20 showy, pink or rose-red flowers; pedicels 0.75–1.25 cm. long; bracts lanceolate, 0.2–0.5 cm. long, scarious; calyx-lobes lanceolate to ovate-lanceolate, acuminate, 0.6–1.5 cm. long, scarious, the squamellae in alternate groups of 2; corolla infundibuliform, the proper-tube straight, 0.8–1.2 cm. long, about 0.15 cm. in diameter at the base, the throat tubular or subtubular, 0.7–1.5 cm. long, about 0.3–0.5 cm. in diameter at the orifice, the lobes obliquely obovate to obovate-oblong, narrowly acute, 1.4–3.0 cm. long, spreading; anthers auriculate, 0.6 cm. long; ovary oblongoid, about 0.1 cm. long, glabrous; stigma 0.2 cm. long, shortly apiculate; nectaries 2, rarely 3–5, compressed-oblongoid, about as long as the ovary; follicles relatively long and slender, continuous, 20–25 cm. long, glabrous; seeds not examined.

BRAZIL: MINAS GERAES: Caldas, in campis, Nov., 1854, *Lindberg 193* (Bx, MBG, photograph); Lagoa Santa, Nov. 23, 1863, *Engle s. n.* (C); Caldas, 1862, *Regnell 875* (Bx, C, M, US); Congonhas do Campo, 1843, *Stephan s. n.* (Bx); "campo," Febr., 1835, *Lund s. n.* (C); data incomplete, *Claussen s. n.* (K); *Widgren 372* (Bx, C, G, M); SÃO PAULO: in campis herbidis supra saxum aren. ferruginosum prope Mogy et Fundiahy, Dec., year lacking, *Martius 504* (M, MBG, photograph); PARANA: Villa Velha, in campo, alt. 875 m., Oct. 23, 1914, *Dusen 1317a* (MBG); Jaguariahyva, in campo, Nov. 28, 1915, *Dusen 17356* (G, US); same locality, Nov. 17, 1914, *Dusen 16023* (US); Tamandua, in campo, Nov. 24, 1910, *Dusen 10854a* (MBG); Desirio Ribas, in campo, Nov. 29. 1910, *Dusen 10875* (AA, G); exact locality lacking, Nov.

30, 1903, *Dusen 14750* (US); Serrinha, in campo, Dec. 7, 1908, *Dusen 7311* (G); RIO GRANDE DO SUL: prope Rio Jacuhy, date lacking, *Tweedie 791* (K, TYPE, MBG, photograph); Neuwurttemburg, Estancia Laurenço Gomez, alt. 500 m., Nov. 21, 1904, *Bornmueller 348* (M); data incomplete, *Sellow 3203* (Bx); *Glaziou 15216* (C); *Sellow 4502* (BB); *Riedel s. n.* (M, BB).

PARAGUAY: in regione fluminis Alto Parana, 1909–10, *Fiebrig 5677* (G, US); Caaguazu, dans les campos, Nov. 11, 1874, *Balansa 1353* (K); in regione vicine Igatimi, Oct., year lacking, *Hassler 4789* (G, K, BB); in altaplanitie et declivibus Sierra de Amambay, Dec., 1907, *Hassler 9801* (K); in regione cursus superioris fluminis Y-aca, Febr., 1900, *Hassler 7125* (BB); in regione fluminis Yhú, Nov., 1905, *Hassler 9609* (G).

URUGUAY: Montevideo, date lacking, *Sellow 1493* (C).

77. **Mandevilla spigeliaeflora** (Stadelm.) Woodson, comb. nov.

Echites (?) *spigeliaeflora* Stadelm. Flora **24**[1]: Beibl. 58. 1841; A. DC. in DC. Prodr. **8**: 469. 1844.

Echites pulchella Gardn. ex Hook. Icon. Pl. **5**: *pl. 470.* 1842.

Dipladenia pulchella (Gardn.) A. DC. loc. cit. 485. 1844.

Dipladenia longiloba A. DC. loc. cit. 1844; Miers, Apoc. So. Am. 157. 1878.

Dipladenia spigeliaeflora (Stadelm.) Muell.-Arg. in Mart. Fl. Bras. **6**[1]: 122. *pl. 37. fig. 1.* 1860; Miers, loc. cit. 1878; K. Sch. in Engl. & Prantl, Nat. Pflanzenfam. **4**[2]: 169. 1895.

Dipladenia spigeliaeflora (Stadelm.) Muell.-Arg. *β. longiloba* (A. DC.) Muell.-Arg. loc. cit. 1860.

Dipladenia xanthostoma (Stadelm.) Muell.-Arg. f. *longiloba* (A. DC.) Malme, Bull. Herb. Boiss. II. **4**: 258. 1904.

Glabrous, erect, suffrutescent herbs from a napiform, tuberous root; stems terete, relatively slender; leaves opposite, shortly petiolate to subsessile, lanceolate to narrowly oblong-elliptic, apex acute to acuminate, base obtuse to rounded, 4–9 cm. long, 0.75–2.0 cm. broad, firmly membranaceous, eglandular or essentially so; petiole 0.2–0.3 cm. long; nodal appendages obsolete; racemes simple, terminal, bearing 5–12 showy, pink or rose-red flowers; pedicels 0.75–1.0 cm. long; bracts linear-lanceolate, acuminate, 0.3–0.6 cm. long, scarious; calyx-lobes lanceolate to ovate-lanceolate, acuminate, 0.2–0.6 cm. long, scarious, the squamellae in alternate groups of 2; corolla infundibuliform, the proper-tube straight, 0.4–0.5 cm. long, about 0.25 cm. in diameter

at the base, the throat tubular or subtubular, 1.0–1.5 cm. long, about 0.3–0.5 cm. in diameter at the orifice, the lobes obliquely oblong-elliptic to narrowly obovate, acute, 1.0–1.5 cm. long, spreading; anthers auriculate, 0.45 cm. long; ovary ovoid-oblongoid, about 0.1 cm. long, glabrous; stigma 0.15 cm. long, obscurely apiculate; nectaries 2, rarely 3–5, compressed-obovoid, about half as long as the ovary; follicles unknown.

BRAZIL: MINAS GERAES: Lagoa Santa, Dec. 20, 1865, *Warming s. n.* (C); same locality, Jan. 12, 1864, *Engle s. n.* (C); inter Lapa and Rio das Velhas, in campis humidis, Jan., 1866, *Engle s. n.* (C); Fazenda Secca, date lacking, *Pohl s. n.* (Bx, M, MBG, photograph and analytical drawings); data incomplete: *Claussen 339* (C, G, MP); *Regnell 874* (US); MATTO GROSSO: Porto Esperidiad, Rio Jauru, campo, date lacking, *Hoehne 695* (US).

PARAGUAY: zwischen Rio Apa und Rio Aquidaban, Berg Camp. quellige Stelle, zwischen Gräsern, Centurian, Nov. 16, 1908, *Fiebrig 4238* (G, M, US); in regione cursus superioris fluminis Apa, Dec., 1901, *Hassler 8143* (BB, G).

Closely related to *M. coccinea*, and possibly better interpreted as a variety of it. *M. spigeliaeflora* has also been reported from the Brazilian states of Goyaz and São Paulo.

Subgen. II. EXOTHOSTEMON (G. Don) Woodson, comb. nov.

Exothostemon G. Don, Hist. Dichlam. Pl. 4: 82. 1838, pro. gen.

Corolla-tube more or less gibbous or arcuate; squamellae as many as the calyx-lobes and opposite them (frequently deeply lacerate in certain species); upper surface of leaves bearing few to several glandular emergences distributed rather irregularly along the midrib. *Spp. 78–108.*

KEY TO THE SPECIES

a. Corolla salverform, the orifice somewhat constricted.
  b. Flowers subsessile, ascending at maturity; leaves firmly chartaceous to subcoriaceous, sagittate.
    c. Bracts scarious, 0.4–0.6 cm. long; leaves glabrous or rarely minutely puberulent to glabrate; plants of Venezuela and the Guianas...*78. M. subspicata*
    cc. Bracts petaloid, 0.75–1.25 cm. long; leaves pubescent to glabrate; plants of Peru, Bolivia, and Brazil.
      d. Bracts abruptly obtuse to broadly acute.............*79. M. antennacea*
      dd. Bracts gradually acuminate........................*80. M. bracteosa*
  bb. Flowers short-pedicellate, somewhat reflexed or resupinate at maturity; leaves delicately membranaceous, somewhat auriculate.
    c. Bracts scarious, 0.1–0.5 cm. long....................*81. M. subsagittata*

cc. Bracts foliaceous or petaloid, 1.0–3.5 cm. long..............*82. M. villosa*

aa. Corolla infundibuliform, or infundibuliform-subsalverform, the orifice not constricted.

b. Lianas; stems terete.

c. Corolla relatively large and showy, yellow or reddish; inflorescence not secund.

d. Corolla infundibuliform-subsalverform, the throat narrowly tubular or subtubular, not greatly inflated.

e. Corolla-tube relatively slender, about 0.1 cm. in diameter at the base; calyx-lobes ovate-lanceolate, acute to acuminate, 0.2–0.3 cm. long; plants of Peru......................*83. M. Pavonii*

ee. Corolla-tube relatively stout, about 0.3 cm. in diameter at the base; calyx-lobes lanceolate, acuminate, 0.4–0.5 cm. long; plants of southern Brazil......................*84. M. lasiocarpa*

dd. Corolla typically infundibuliform, the throat conical to narrowly campanulate (broadly tubular in *M. Sagittarii*), greatly inflated.

e. Bracts scarious, relatively inconspicuous.

f. Leaves smooth or somewhat rugose above, softly tomentose to glabrate, infrequently glabrous; calyx-lobes acuminate.

g. Corolla-throat conical to conical-campanulate.

h. Bracts ovate to lanceolate, 0.6 cm. long or less; foliar indument not ferruginous if present; species of Colombia, Trinidad, Venezuela, the Guianas, and northern Brazil.

i. Leaves broadly ovate to ovate-oblong, rarely oblong-lanceolate; corolla-throat conical-campanulate; follicles short and stout, conspicuously moniliform.....................................*85. M. mollissima*

ii. Leaves broadly elliptic to linear-lanceolate; corolla-throat conical; follicles relatively long and slender, continuous or only slightly articulated.

j. Leaves broadly elliptic to elliptic-lanceolate; inflorescence several- to many-flowered.

k. Corolla 4–7 cm. long; vegetative parts velutinous-pilose to glabrate.

l. Leaves firmly membranaceous, smooth above.....................................*86. M. scabra*

ll. Leaves coriaceous, rugose above.........*87. M. rugosa*

kk. Corolla 9–10 cm. long; vegetative parts glabrous to glabrate...................*88. M. symphitocarpa*

jj. Leaves linear to linear-elliptic; inflorescence few- to several-flowered.....................*89. M. leptophylla*

hh. Bracts linear, about 1 cm. long; foliar indument ferruginous; plants of Bolivia...................*90. M. rutila*

gg. Corolla-throat narrowly campanulate.

h. Corolla-throat relatively broad, 1.0–1.25 cm. in diameter at the orifice............................*91. M. Fendleri*

hh. Corolla-throat relatively narrow, about 0.75 cm. in diameter at the orifice.

i. Leaves narrowly elliptic-lanceolate, the base attenuate, not cordate; flowers subsessile..............*92. M. Schlimi*
ii. Leaves broadly ovate-lanceolate, conspicuously and narrowly cordate; flowers distinctly pedicellate...*93. M. Trianae*
ff. Leaves scabrous, strigillose above; calyx-lobes ovate-reniform, broadly obtuse or rounded.....................*94. M. scaberula*
ee. Bracts foliaceous or petaloid, large and showy.
f. Bracts ovate to ovate-lanceolate, sessile.
g. Leaves puberulent to glabrate above; follicles relatively slender and flexile..........................*95. M. bracteata*
gg. Leaves strigillose above; follicles relatively stout and rigid.
h. Corolla-throat conical to conical-campanulate...*96. M. hirsuta*
hh. Corolla-throat broadly tubular...............*97. M. sagittarii*
ff. Bracts oblanceolate or spatulate, with a slender claw...*98. M. Moritziana*
cc. Corolla relatively small and inconspicuous, greenish-yellow; inflorescence secund.................................*99. M. polyantha*
bb. Low, erect, or very rarely somewhat volubile, suffruticose undershrubs; stems alate or more or less compressed.
c. Bracts scarious, relatively small and inconspicuous.
d. Leaves strictly opposite.
e. Plants glabrous or essentially so.
f. Leaves obovate to obovate-lanceolate, or oblong-elliptic.
g. Calyx glabrous; leaves chartaceous............*100. M. caurensis*
gg. Calyx minutely papillate; leaves coriaceous.
h. Leaves elliptic to obovate-lanceolate, attenuate and somewhat cuneate at the base; pedicels 0.1–0.3 cm. long.
i. Stems conspicuously alate; leaves 5–8 cm. long; corolla 4.5–6.0 cm. long; stigma obscurely apiculate...*101. M. Vanheurckii*
ii. Stems inconspicuously alate; leaves 10–12 cm. long; corolla 8 cm. long; stigma long-apiculate.......*102. M. Ulei*
hh. Leaves broadly oblong-elliptic, rounded and obscurely cordate at the base; pedicels 0.4–0.6 cm. long...*103. M. subcarnosa*
ff. Leaves linear-lanceolate.......................*104. M. lancifolia*
ee. Plants densely pubescent.........................*105. M. anceps*
dd. Leaves verticillate.............................*106. M. Benthamii*
cc. Bracts foliaceous or petalaceous, large and showy.
d. Bracts not navicular or conduplicate, the apex rounded or broadly obtuse; corolla 6–8 cm. long....................*107. M. javitensis*
dd. Bracts somewhat navicular or conduplicate, the apex long-acuminate; corolla 5–7 cm. long......................*108. M. Spruceana*

78. Mandevilla subspicata (Vahl) Mgf. Rec. Trav. Bot. Neèrl. **22**: 380. 1926.

Echites subspicata Vahl, Eclog. Am. **2**: 18. 1798; A. DC. in DC. Prodr. **8**: 467. 1844.

Echites Guianensis A. DC. loc. cit. 458. 1844.
Echites Prieurei A. DC. loc. cit. 1844.
Amblyanthera Guianensis (A. DC.) Muell.-Arg. Linnaea **30**: 448. 1860.
Amblyanthera Prieurei (A. DC.) Muell.-Arg. loc. cit. 1860.
Angadenia Prieurii (A. DC.) Miers, Apoc. So. Am. 182. 1878, sphalm.
Mesechites Guianensis (A. DC.) Miers, loc. cit. 235. 1878.
Laseguea venustula Miers, loc. cit. 252. 1878.
Laseguea subspicata (Vahl) Miers, loc. cit. 1878.

Suffruticose lianas; stems terete, relatively stout, minutely and sparsely pilose when young, soon becoming glabrate; leaves opposite, petiolate, rather broadly ovate-lanceolate, apex rather gradually acuminate, base somewhat sagittate, 8–12 cm. long, 3.5–7.0 cm. broad, chartaceous to subcoriaceous, either surface glabrous or infrequently minutely puberulent to glabrate beneath, the upper glandular along the midrib; petiole about 0.5 cm. long; inflorescence lateral, simply racemose, about equalling the length of the subtending leaves, bearing 8–20 whitish or cream-colored flowers; pedicels 0.1 cm. long, or somewhat less, ascending, not reflexed or resupinate at the maturity of the flowers; bracts lanceolate, 0.4–0.6 cm. long, scarious; calyx-lobes lanceolate, acuminate, 0.1–0.3 cm. long, scarious, glabrous, the opposite, solitary squamellae trigonal-ligular, frequently slightly erose or laciniate; corolla salverform, glabrous without, the tube about 2.0–2.25 cm. long, about 0.15 cm. in diameter at the base, somewhat narrowing toward the insertion of the stamens, more or less gibbous, but not ventricose, the lobes obliquely obovate, 1.5 cm. long, widely spreading or reflexed; anthers auriculate, 0.4 cm. long; ovary ovoid, about 1.5 cm. long, glabrous; stigma 0.3 cm. long, shortly apiculate; nectaries 5, compressed-ovoid, about half as long as the ovary; follicles relatively slender, glabrous, remotely and rather indistinctly articulated, falcate or somewhat divaricate, 10–15 cm. long; seeds about 1 cm. long, the brilliant tawny coma 1.5–2.0 cm. long.

Venezuela: Catalina, May, 1896, *Rusby & Squires 293* (K, NY, US).

British Guiana: Anabisi River, Northwest District, Febr. 14, 1922, *Cruz 1335* (FM); exact locality lacking, 1840, *Talbot s. n.* (K).

DUTCH GUIANA: Para District, date lacking, *Wüllschlagel 1972* (B); Aboutjoeman, May 16, 1910, *Landlouw 297* (B); Saramacca superiore, date lacking, *Pulle 493* (B); Coppename superiore, date lacking, *Boon 1120* (B); exact locality and date lacking, *Hostmann & Kappler 123* (S); *von Rohr s. n.* (B, drawing, C); *von Rohr s. n.* (C, TYPE, B, drawing, MBG, photograph and analytical drawings).

FRENCH GUIANA: among shrubs, near wireless station, vicinity of Cayenne, July 3, 1921, *Broadway 643* (NY); Charoni, date lacking, *Wackenheim 254* (US); Cayenne, date lacking, *Martin s. n.* (K); Godebert, Dec., 1919, *Wackenheim 68* (K); Cayenne, date lacking, *Perrottet s. n.* (DL); Cayenne, date lacking, *le Blond s. n.* (H); DATA INCOMPLETE: 1855, *Sagot 382* (BM, K, V); 1820, *le Prieur s. n.* (DL); 1834, *le Prieur 241* (DC).

79. Mandevilla antennacea (A. DC.) K. Sch. in Engl. & Prantl, Nat. Pflanzenfam. 4²: 171. 1895.

Echites antennacea A. DC. in DC. Prodr. **8**: 456. 1844.

Amblyanthera antennacea (A. DC.) Muell.-Arg. Linnaea **30**: 448. 1860.

Laseguea antennacea (A. DC.) Miers, Apoc. So. Am. 251. 1878.

Echites Boliviana Britton in Rusby, Mem. Torrey Bot. Club **4**: 219. 1895.

Mandevilla Boliviana (Britton) Rusby, Bull. Torrey Bot. Club **25**: 496. 1898.

Echites altescandens H. Winkl. in Fedde, Rep. Sp. Nov. **7**: 243. 1909.

Mandevilla tenuicarpa Rusby, Bull. N. Y. Bot. Gard. **8**: 114. 1912.

Suffruticose lianas; stems terete, relatively stout, softly puberulent when young, becoming glabrate; leaves opposite, petiolate, elliptic-ovate to oblong-lanceolate, apex acute to acuminate, base obscurely sagittate, 5–12 cm. long, 1.5–6.0 cm. broad, chartaceous to subcoriaceous, above minutely strigillose to glabrate, glandular along the midrib, beneath softly tomentulose or puberulent, particularly along the veins; petiole 0.5 cm. long; inflorescence lateral, simply racemose, usually equalling or somewhat exceeding the length of the subtending leaves, bearing 8–50 crowded, yellowish flowers; pedicels 0.1–0.2 cm. long; bracts oblong, obtuse to broadly acute, 0.75–1.25 cm. long, petaloid; calyx-lobes lanceolate to oblong-lanceolate, acuminate, 0.2–0.3 cm. long, scarious, glabrous or minutely and irregularly puberulent-papillate, the opposite, solitary squamellae subtri-

gonal, erose; corolla salverform, glabrous without, the tube 2.5–3.0 cm. long, about 0.2 cm. in diameter at the base, distinctly gibbous, slightly enlarged at the insertion of the stamens, the lobes obliquely ovate or obovate, reflexed or spreading, 1.5–2.0 cm. long; anthers auriculate, 0.4 cm. long; ovary ovoid, about 0.2 cm. long, glabrous; stigma 0.15 cm. long, obscurely apiculate; nectaries 5, ovoid-trigonal, about half as long as the ovary; follicles slender, obscurely articulated, 8–20 cm. long; seeds about 0.75 cm. long, the brilliant tawny coma about 2 cm. long.

PERU: JUNIN: Chanchamayo Valley, alt. 1000 m., Feb., 1924–27, *Schunke 391* (FM); same locality, alt. 1200 m., Dec., 1924–27, *Schunke 389* (FM); Colonia Perene, alt. about 680 m., thickets, June 14–25, 1929, *Killip & Smith 25407* (US); LORETO: stromgebiet des Maranon von Jquitos aufwärts bis zur Santiago-Mündung am Pongo de Manseriche, ca. 77° 30′ West., Feb. 12, 1925, *Tessmann 5064* (B); same locality and date, *Tessmann 3587* (B); Moyobamba, alt. 800–900 m., Aug. 7, 1904, *Weberbauer 4488* (B); Yurimaguas, Rio Huallaga, loco non inundabili, Febr. 15, 1924, *Kuhlmann 21849* (B, US).

BOLIVIA: LA PAZ: Ixiamas, alt. 800 ft., Dec. 11, 1921, *White 1142* (K, NY, US); Guani, alt. 2000 ft., May, 1886, *Rusby 2380* (G, K, NY, FM, US); same locality and date, *Rusby 2379* (NY); Tumupasa, alt. 1800 ft., *Williams 875* (B, BM, K, NY); Yungas, 1890, *Bang 551 in part* (FM, MBG, NY, US); Charopampa, vicinity of Mapiri, Schlingstrauch viele Metr. hoch steigend, alt. 570 m., Nov., 1907, *Buchtien 1968* (US); Polo-Polo, bei Coroico, Nordyungas, alt. 1100 m., Oct.–Nov. 1912, *Buchtien 4672* (US); same locality and date, *Buchtien 5918* (US); Mapiri, alt. 1600 ft., Sept. 17, 1901, *Williams 804* (BM, NY, US); Tumupasa, Dec., 1901, *Williams 536* (BM, NY); Mapiri Región: San Carlos bei Sarampiuni, alt. 600 m., Nov. 10, 1926, *Buchtien 1198* (US); exact locality and date lacking, *Bang 2057* (NY, US).

BRAZIL: AMAZONAS: Santo Antonio do Yea, Aug. 26, 1906, *Ducke 21768* (B).

80. Mandevilla bracteosa (Rusby) Woodson, comb. nov.
Echites bracteosa Rusby, Mem. N. Y. Bot. Gard. **7**: 325. 1927.

Suffruticose lianas; stems terete, relatively stout, densely hirtellous to glabrate; leaves opposite, petiolate, broadly oblong- to ovate-elliptic, apex acuminate, base obscurely sagittate, 7–12 cm. long, 2.5–5.0 cm. broad, chartaceous to subcoriaceous, above minutely strigillose, beneath densely and minutely tomentulose; petiole 0.5–0.75 cm. long; racemes lateral, somewhat longer than the subtending leaves, bearing 15–20 showy, reddish-yellow flowers; pedicels 0.1–0.2 cm. long; bracts extremely conspicuous, petaloid, narrowly lanceolate, long-acuminate, 1.0–1.25 cm. long; calyx-lobes ovate-lanceolate, acuminate, about 0.2 cm. long,

scarious, minutely and sparsely puberulent without, the opposite, solitary squamellae deltoid, entire or merely somewhat erose; corolla salverform, glabrous without, the tube distinctly gibbous, 2.25 cm. long, about 0.1 cm. in diameter at the base, somewhat dilated at the insertion of the stamens, minutely puberulent-papillate without, the lobes broadly obovate, 0.75 cm. long, reflexed or sharply spreading; stamens inserted somewhat above midway within the corolla-tube, the anthers auriculate, 0.5 cm. long; ovary oblongoid, 0.1 cm. long, glabrous; nectaries 5, ovoid-quadrate, about half as long as the ovary; stigma 0.15 cm. long, shortly apiculate; follicles slender, rather indistinctly articulate or torulose, 15–20 cm. long, glabrous; seeds about 1 cm. long, the pale tawny coma 2.5 cm. long.

BOLIVIA: LA PAZ: Ixiamas, alt. 700–800 ft., Dec. 16, 1921, *White 1142* (NY, TYPE, MBG, photograph and analytical drawings).

This species is somewhat dubiously regarded as distinct from *M. antennacea* (A. DC.) K. Sch. on the grounds of the more attenuate, petaloid bracts. Additional specimens may prove the two species to intergrade.

81. **Mandevilla subsagittata** (R. & P.) Woodson, Ann. Mo. Bot. Gard. **19**: 69. 1932.

Echites subsagittata R. & P. Fl. Peruv. **2**: 19. 1799; A. DC. in DC. Prodr. **8**: 475. 1844; Miers, Apoc. So. Am. 198. 1878.

Echites hirtella HBK. Nov. Gen. **3**: 213. 1819; A. DC. loc. cit. 465. 1844.

Echites gracilis HBK. loc. cit. 219. 1819; A. DC. loc. cit. 460. 1844.

Echites speciosa HBK. loc. cit. 1819; A. DC. loc. cit. 1844.

Echites mucronata R. & S. Syst. **4**: 796. 1819.

Exothostemon gracile (HBK.) G. Don, Hist. Dichlam. Pl. **4**: 82. 1838; Miers, loc. cit. 240. 1878.

Exothostemon speciosum (HBK.) G. Don, loc. cit. 1838; Miers, loc. cit. 241. 1878.

Echites Guayaquilensis Benth. Pl. Hartw. 119. 1839.

Echites jasminiflora Mart. & Gal. Bull. Acad. Roy. Brux. **11**: 357. 1844.

Echites microcalyx A. DC. loc. cit. 456. 1844; Miers, loc. cit. 203. 1878.

Echites microcalyx A. DC. β. *glabra* A. DC. loc. cit. 1844.

Echites hirtiflora A. DC. loc. cit. 1844; Miers, loc. cit. 200. 1878.

Echites membranacea A. DC. loc. cit. 457. 1844; Miers, loc. cit. 196. 1878.

Echites secundiflora A. DC. loc. cit. 1844.

Amblyanthera membranacea (A. DC.) Muell.-Arg. Linnaea **30:** 423. 1860.

Amblyanthera microcalyx (A. DC.) Muell.-Arg. loc. cit. 428. 1860.

Amblyanthera microcalyx (A. DC.) Muell.-Arg. α. *hirtiflora* (A. DC.) Muell.-Arg. loc. cit. 1860.

Amblyanthera microcalyx (A. DC.) Muell.-Arg. β. *trichantha* Muell.-Arg. loc. cit. 1860.

Amblyanthera microcalyx (A. DC.) Muell.-Arg. γ. *leiantha* Muell.-Arg. loc. cit. 429. 1860.

Echites acuminata Willd. ex Muell.-Arg. loc. cit. 1860, nom. nud. in synon., not R. & P.

Amblyanthera microcalyx (A. DC.) Muell.-Arg. δ. *leiophylla* Muell.-Arg. loc. cit. 1860.

Amblyanthera microcalyx (A. DC.) Muell.-Arg. ε. *glabra* (A. DC.) Muell.-Arg. loc. cit. 1860.

Temnadenia secundiflora (A. DC.) Miers, loc. cit. 211. 1878.

Mesechites hastata Miers, loc. cit. 233. 1878.

Mesechites Guayaquilensis (Benth.) Miers, loc. cit. 1878.

Mesechites hirtella (HBK.) Miers, loc. cit. 234. 1878.

Mesechites jasminiflora (Mart. & Gal.) loc. cit. 235. 1878.

Echites cuspidifera S. F. Blake, Contr. Gray Herb. **52:** 79. 1917.

Glabrous or variously pubescent, suffrutescent lianas; stems terete, relatively slender; leaves opposite, petiolate, oblong-elliptic, infrequently narrowly lanceolate, apex somewhat gradually acuminate, rarely abruptly obtuse or rounded, mucronulate, base rather gradually narrowed and abruptly auriculate, commonly almost subhastate, 2–10 cm. long, 0.5–3.0 cm. broad, membranaceous, the upper surface glandular along the midrib;

petiole 0.5–1.0 cm. long; racemes lateral, equalling or somewhat surpassing the subtending leaves, bearing 8–20 alternate, yellow or reddish flowers; pedicels 0.4–0.6 cm. long, more or less reflexed and resupinate at maturity; bracts lanceolate, 0.1–0.5 cm. long, scarious; calyx-lobes narrowly trigonal, 0.1–0.15 cm. long, scarious, glabrous to scatteringly pilosulose, the opposite, solitary squamellae trigonal-ligular, usually more or less erose; corolla salverform, the tube 2.0–2.5 cm. long, about 0.2 cm. in diameter at the base, conspicuously narrowing toward the insertion of the stamens, more or less gibbous and ventricose below, the lobes broadly and obliquely obovate, acuminate, 1.0–1.5 cm. long, reflexed or widely spreading; stamens inserted near the orifice of the corolla-tube, the anthers auriculate, 0.5 cm. long; ovary oblong-ovoid, about 0.15 cm. long, glabrous; stigma 0.3 cm. long, shortly apiculate; nectaries 5, compressed ovoid, usually retuse, about half as long as the ovary; follicles relatively slender, conspicuously moniliform, 10–20 cm. long, glabrous; seeds about 0.75 cm. long, the tawny coma about 1.5 cm. long.

MEXICO: TABASCO: entre San Juan Bautista y "El Cometa" (Fabarco), July 9, 1888, *Revirosa 225* (PA, K); road to San Juan Bautista to Atasta (Fabarco), March 14, 1888, *Revirosa 126* (PA, US); MICHOACAN: Chaveta, Oct. 26, 1898, *Langlassé 519* (B, G, K, US); OAXACA: near Pchutla, alt. 200 m., Sept. 28–Nov. 4, 1917, *Reko 3411* (US); Las Frias Aguas, Distrito de Cuicatlan, Aug. 21, 1909, *Conzatti 3514* (US); vicinity of Choapam, alt. 3800–4500 ft., July 28–29, 1894, *Nelson 866* (US); near Totontepec, alt. 5500–5700 ft., July 15–28, 1894, *Nelson 809* (US); Ixcatlan, Aug. 19, 1895, *L. C. Smith 660* (G); Tentilla, alt. 3300 ft., Aug. 16, 1895, *L. C. Smith 691* (G); exact locality lacking, alt. 4000 pp., date lacking, *Galeotti 1602* (Bx); VERA CRUZ: region of Orizaba, July 12, 1865–66, *Bourgeau 2710* (B, BB, Bx, G, K, S, US); Wartenberg, near Tantoyuca, Prov. Huasteca, 1858, *Ervendberg 217* (G, BB); Zacuapan and vicinity, Nov., 1906, *Purpus 2215* (FM, G, MBG, US); Misantla, July, 1912, *Purpus 5906* (BM, FM, G, MBG); Zacuapan, Aug., 1914, *Purpus 7281* (AA, BM, FM, MBG, US); open forest, Zacuapan, July, 1926, *Purpus 10739* (S, US); hillsides, same locality, Oct., 1926, *Purpus 10885* (S, US); Vera Cruz, July, 1838, *Linden 359* (BB, K); little woods near Vera Cruz, date lacking, *Galeotti 1575* (Bx, K); YUCATAN: exact locality lacking, 1895, *Gaumer 881* (BM, FM); at Buena Vista, Xbac, date lacking, *Gaumer 1158* (US); at San Anselmo, date lacking, *Gaumer 2013* (FM, MBG); Chichankanab, date lacking, *Gaumer 2014* (BM, C, FM, S, US); same locality, *Gaumer 2228* (C, FM, G, MBG, S, US); Merida, Oct., year lacking, *Moritz 1153* (K, B); data incomplete: *Schiede 167* (B); *Sartorius s. n.* (B).

GUATEMALA: IZABAL: Los Amates, Feb. 15, 1908, *Kellermann 7564* (NY); bushy slope, vicinity of Quirigua, alt. 75–225 m., May 15–31, 1922, *Standley 24512* (US); Christina, in slough, May 23, 1919, *Blake 7651* (US); GUATEMALA: near Guatemala City, Aug., 1921, *Tonduz 827* (NY, US); Guatemala City, 1892, *Heyde 172* (US); on the plains, near Guatemala, towards Chinanta, July, 1860, *Hayes 318* (FM, G, US);

forest along Saklak River, alt. 300 m., below Secanquim, May 7, 1905, *Pittier 304* (US); Secanquim, trail to Setzapec, Nov. 28, 1904, *Goll 95* (US); near Cajabon, near the Finca Sepaxuite, April 26, 1902, *Cook & Griggs 769* (US); Monte Blanco, alt. 1000 m., June, 1902, *Tuerckheim 8369* (US); SANTA ROSA: Cenaguilla, alt. 4000 pp., Sept., 1892, *Heyde & Lux 3992* (B, C, K, MBG, NY, US); Cerro Redondo, alt. 1500 m., Oct. 1893, *Heyde & Lux 6186* (B, BB, BM, G, K, US); BAJA VERAPAZ: locality lacking, Oct., 1912, *Tuerckheim 3924* (FM, US).

BRITISH HONDURAS: lower Belize River, Febr., 1926, *Record s. n.* (K, US); Honey Camp, Orange Walk, 1928, *Lundell s. n.* (FM, K, MBG, US); climber growing over low bushes in swampy places, Stann Creek Railway, alt. 50 ft., Sept. 22, 1929, *Schipp 368* (AA, BM, FM, G); Pine Ridge, near Manatee Lagoon, June 11, 1905, *Peck 35* (G).

HONDURAS: SANTA BARBARA: San Pedro Sula, alt. 300 m., April, 1890, *Thieme 5347* (G, US); same locality, Nov., 1888, *Thieme 5346* (US); COMAYAGUA: pine forest, vicinity of Siguatepeque, Dept. Comayagua, alt. 1080–1400 m., Febr. 14–27, 1928, *Standley 56470* (FM); same locality and date, *Standley 56365* (FM); DEPARTMENT UNCERTAIN: La Cumbre, on oaks and pines, Oct. 26, 1888, *Thieme 517* (US); La Cumbre, mountainside, Oct. 7, 1888, *Thieme 622* (US, K); Bonacco Island, 1887, *Gaumer s. n.* (US).

COSTA RICA: ALAJUELA: hills of Santiago, near San Ramon, May 25, 1901, alt. 1100 m., *Brenes 14273* (B, G); DATA INCOMPLETE: April, 1910, *Worthen s. n.* (MBG).

SALVADOR: San Salvador, 1922, *Calderon 815* (US).

NICARAGUA: MATAGALPA: Monte Grande, alt. 1050 m., Sept. 2, 1894, *Rothschub 614* (B).

PANAMA: Punta Bruja, Sept., 1924, *Stevens 538* (US); Mirador, date lacking, *Sartorius s. n.* (B, US); Panama Sta., July, 1861, *Hayes 345* (BM, K).

COLOMBIA: CUNDINAMARCA: open road bank, Caqueza to Rio Sananie, alt. 1600 m., Aug. 24, 1917, *Pennell 1330* (G); Copo, Vallée du Magdalena, alt. 1200 m., 1851–57, *Triana s. n.* (BM); META: trail in thicket, Villavicencio, alt. 500 m., Aug. 26–31, 1917, *Pennell 1390* (G, US); grassy liano, east of Villavicencio, alt. 450 m., Sept. 1–2, 1917, *Pennell 1633* (NY); MAGDALENA: Santa Marta, alt. 250 ft., Oct., 1898–1901, *H. H. Smith 1662* (B, BM, Bx, K, MBG, US); Santa Marta, 1898–1901, *H. H. Smith 2413* (B, FM, K, MBG, NY, US); Santa Marta, date lacking, *Purdie s. n.* (K); prope Santa Marta, July, 1832, *Linden 967* (BB, K); S. Ana Nova-Granatentium, date lacking, *Humboldt & Bonpland s. n.* (B); ANTIOQUIA: vicinity of Medellin, April 15, 1927, *Toro 163* (NY); VALLE DEL CAUCA: La Manuelita, near Palmira, eastern side of Cauca Valley, alt. 1100–1302 m., Dec., 1906–Jan. 1907, *Pittier 810* (NY).

VENEZUELA: SUCRE: Island of Margarita, San Juan, alt. 750 m., July 11, 1903, *Johnston 137* (G); MERIDA: savannas, Meseta near Tovar, alt. 1100 m., Jan. 30, 1928, *Pittier 12778* (MC, US); CARABOBO: between Valencia and Campanero, also Biscaina, alt. 300 m., 1854–55, *Fendler 1033* (G, K, MBG, NY); San Estevan, Dec., 1843, *Linden 1503* (BM, DL); MIRANDA: Quebrada de Turumo, cerca de Guarenas, Dec. 2, 1923, *Pittier 11278* (MC, US); Las Mostazas, ferro-carril de Los Teques a Tejerias, alt. 963 m., Nov., 1924, *Allart 203* (MC); La Cortada, en la carretera a Guatire, cerca de Petare, en matorrales, Nov. 11, 1923, *Pittier 11228* (MC, US); DISTRITO FEDERAL: hills above Los Teques, in brushes, Sept. 7, 1924, *Pittier 11597* (MC, NY, US); La Guagra, Caracas, July 1, 1874, *Kuntze 1331* (NY); Caracas, 1829, *Vargas 109* (DC); bosques de Catuche, cerca de Caracas, en lugares asoleados, Aug. 7, 1921,

Pittier 9650 (MC, NY, US); Cotiza, cerca de Caracas, en matorrales, Aug. 8, 1917, *Pittier 7300* (MC); El Valle, Caracas, June 25, 1891, *Eggers 13166* (US); LARA: Rio de Sarare, alt. 300–450 m., Aug. 3, 1930, *Saer s. n.* (MC); ARAGUA: Valle de Ocumare de la Costa, en silva humeda, Oct. 13, 1927, *Pittier 12558* (MC); ZULIA: mountains near Guayabo, alt. 4–5000 ft., Dec., 1854, *Birscher s. n.* (K).

TRINIDAD: Trinidad, April, 1874, *Kuntze 689* (NY); Carenage, hillside thicket, March 29, 1921, *Britton & Broadway 2626* (NY, US); road to Maracas Bay, South, Sept. 14, 1927, *Broadway 6733* (K, US); St. Anne's Cascade, Dec. 4, 1923, *Broadway s. n.* (MBG); exact locality and date lacking, *Sieber 92* (B, DC, DL, K, MBG, S); Maracas Falls, June 11, 1903, *Johnston 53* (G); Oroponche, along the roadside, Dec. 19, 1907, *Nurse 2158* (B, FM); Darrell Spring Road, June 29, 1910, *Broadway 3848* (B, BM, FM, S); Belmont Valley Road, Nov. 8, 1909, *Broadway 2840* (B, FM); exact locality and date lacking, *Lockhart s. n.* (K); Maraval Valley, April, 1848, *Purdie s. n.* (K); Radix Point, Mayaro, July 3, 1927, *Williams & Sampson 11735* (K); exact locality lacking, 1877–80, *Fendler 622, 624* (BM); Tobago, prope Bacolet, in collibus, Oct. 20, 1889, *Eggers 5482* (B, US).

ECUADOR: GUAYAS: Guayaquil, 1837, *Hartweg 669* (BM, Camb., DL, K); Guayaquil, date lacking, *Pavon s. n.* (BB); exact locality lacking, April 12, 1897, *Eggers s. n.* (B, FM).

PERU: HUANUCO: Pozuzo, June 20–22, 1923, *Macbride 4720* (FM); Casapi, 1835, *Matthews 1977* (K); LORETO: prope Tarapoto, Peruvia Orientalis, 1855–56, *Spruce s. n.* (K, V); Tarapoto, 1835, *Matthews 1327* (K); CAJAMARCA: Tal des Flusses Tabaconas, bei der Hacienda Charape, Prov. Taën, alt. 1200–1300 m., April 21, 1912, *Weberbauer 6270* (B); Peruvia subandina, in fruticetis ad Chihuamceala, Pr. Cuchero, July, 1829, *Poeppig 1233* (V); DATA INCOMPLETE: *Poeppig 144* (BB).

M. subsagittata is probably the most variable species of the genus *Mandevilla*. Although the variability expresses itself chiefly in the presence and character of pubescence, such factors as the outline and size of the leaf, length of petiole and pedicel, and size of flower have also been found unstable. Mueller was inclined to view the collective species as interpreted above as consisting of at least five distinct varieties. Other writers, notably Kunth, A. de Candolle, and Miers, were able to distinguish several species within the complex.

82. **Mandevilla villosa** (Miers) Woodson, Ann. Mo. Bot. Gard. 19: 70. 1932.

Lasequea villosa Miers, Apoc. So. Am. 250. 1878.

Echites comosa O. Ktze. Rev. Gen. 2: 414. 1891.

Suffrutescent lianas; stems terete, relatively slender, finely pilose to glabrate; leaves opposite, petiolate, elliptic to obovate-elliptic, apex rather abruptly acuminate, base obscurely auriculate, commonly almost subhastate, 3–9 cm. long, 1.5–4.0 cm. broad, membranaceous, beneath finely and densely pilose, infrequently

glabrate, rarely glabrous, above finely and rather sparsely pilose to glabrate, not infrequently glabrous or essentially so, glandular along the midrib; petiole 0.4–2.5 cm. long; racemes lateral, equalling or somewhat surpassing the subtending leaves, bearing 8–20 alternate, yellowish or reddish flowers; pedicels 0.2–0.4 cm. long, more or less reflexed and resupinate at maturity; bracts lanceolate to ovate-lanceolate, 1.0–3.5 cm. long, foliaceous or petaloid; calyx-lobes narrowly trigonal, acute to acuminate, 0.1–0.15 cm. long, scarious, puberulent-papillate to glabrate, the opposite, solitary squamellae triangular-ligular; corolla salverform, finely and sparsely pilose to glabrate without, the tube more or less gibbous and ventricose below, 1.5–2.0 cm. long, about 0.2 cm. in diameter at the base, finely and rather sparsely pilose to glabrate without, the lobes obliquely obovate-oblong, 1.0–1.5 cm. long, reflexed or widely spreading; stamens inserted about midway within the corolla-tube, the anthers 0.4 cm. long, auriculate; ovary oblong-ovoid, about 0.15 cm. long, glabrous; stigma 0.2 cm. long, shortly apiculate; nectaries 5, compressed-ovoid, about half as long as the ovary; follicles relatively slender, conspicuously moniliform, 10–15 cm. long; seeds about 0.75 cm. long, the pale tawny coma about 1.5 cm. long.

MEXICO: CHIAPAS: Sierra de Tonala, Sept., 1913, *Purpus 6929* (MBG, US).

GUATEMALA: RETALHULEU: Rio Samala, alt. 1100 pp., Oct., 1891, *Shannon 218* (US); Retalhuleu, Oct., 1866–78, *Bernoulli & Cario 1821* (K); SOLOLA: Santa Barbara, alt. 1370 pp., Aug., 1891, *Shannon 251* (US).

NICARAGUA: exact locality lacking, 1848, *Seemann 95* (K, BM).

SALVADOR: San Salvador, July, 1922, *Calderon 938* (NY, US).

COSTA RICA: Rio Toro Amarillo, Llanuras de Santa Clara, alt. 300 m., July 1899, *Pittier 7598* (US).

PANAMA: COLON: Colon, July 11, 1874, *Kuntze 1891* (NY); PANAMA: Sabana de Juaguito, near Chejo, alt. 60–80 m., 1911, *Pittier 4756* (US); CANAL ZONE: Gatun Sta., Oct., 1859, *Hayes 116* (G, US); France Field, Oct., 1924, *Stevens 1006* (US); Cerro Gordo, near Culebra, alt. 50–290 m., June 29, 1911, *Pittier 3736* (US, MBG); Barbour Point, Barro Colorado Isl., Aug. 29–30, 1929, *Bangham 494* (AA).

VENEZUELA: AMAZONAS: San Carlos, upper Rio Negro, July, 1853, *Spruce 3051* (K); in Orinoci ripis, frequens, June, 1856, *Spruce 3599* (K).

Among the species of subgen. *Exothostemon* there appears an interesting and perplexing parallelism of scarious and subfoliaceous bracted groups. *M. villosa* differs from *M. subsagittata* in the size and character of the floral bracts and in no other evident and consistent feature. Likewise, *M. bracteata* and *M. mollissima*

are separable upon the same character. In *M. antennacea* the floral bracts reach a greater development than in the closely-related *M. subspicata*. In all but the last-mentioned species, the scarious and subfoliaceous-bracted forms occupy almost identical geographical ranges. Quite possibly the greater development of the bracts may not represent an actual specific criterion, and those species differing from their nearest relatives only in that respect and usually occupying a more restricted range and found only in fewer numbers, may be in reality only varieties or even forms of a parent species. However, specific rank has provisionally been assigned to scarious- and subfoliaceous-bracted forms in the absence of intergrading specimens and an intimate knowledge of the plants in the field.

83. **Mandevilla Pavonii** (A. DC.) Woodson, Ann. Mo. Bot. Gard. **19**: 73. 1932.

Echites hirsuta R. & P. Fl. Peruv. **2**: 19. *pl. 136*. 1799; Miers, Apoc. So. Am. 198. 1878, not A. Rich.

Prestonia hirsuta (R. & P.) Spreng. Syst. **1**: 637. 1825.

Echites Pavonii A. DC. in DC. Prodr. **8**: 463. 1844.

Amblyanthera Pavonii (A. DC.) Muell.-Arg. Linnaea **30**: 450. 1860.

Suffruticose lianas; stems terete, relatively stout, ferruginous-hispid to glabrate; leaves opposite, petiolate, elliptic-obovate, apex abruptly subcaudate-acuminate, base rather obscurely auriculate, 8–11 cm. long, 3–5 cm. broad, membranaceous, above minutely strigillose, glandular along the midrib, beneath minutely ferruginous-tomentulose; petiole 1.25–2.5 cm. long; racemes lateral, somewhat shorter than the subtending leaves, bearing 10–15 showy, reddish-yellow flowers; pedicels 0.6–0.8 cm. long; bracts minutely ovate, scarious; calyx-lobes ovate-lanceolate, acute to acuminate, 0.2–0.3 cm. long, scarious, minutely tomentulose, the opposite, solitary squamellae trigonal, truncate; corolla infundibuliform-subsalverform, puberulent without, the tube 3.0–3.5 cm. long, inconspicuously gibbous, somewhat inflated above the insertion of the stamens, about 0.1 cm. in diameter at the base, 0.3–0.35 cm. in diameter at the orifice, the lobes obliquely obovate, 2.0–2.25 cm. long, widely spreading; stamens inserted somewhat

above midway within the corolla-tube, the anthers auriculate, 0.45 cm. long; ovary oblongoid-ovoid, about 0.2 cm. long, glabrous or minutely papillate; stigma 0.2 cm. long, shortly apiculate; nectaries 5, oblongoid, about as long as the ovary; mature follicles unknown.

PERU: LORETO: Mishuyacu, near Iquitos, alt. 100 m., forest, April, 1930, *Klug 1288* (US); same locality, Oct.–Nov., 1929, *Klug 57* (US); in fruticetis ad missionem Tocache, June, 1830, *Poeppig 1840* (V).

84. Mandevilla lasiocarpa (A. DC.) Malme, Bihang till K. Sv. Vet. Akad. Handl. Afd. III. **24**[10]: 25. 1899.

Echites hirsuta R. & P. β. *angustifolia* Stadelm. Flora **24**[1]: Beibl. 26. 1841.

Echites lasiocarpa A. DC. in DC. Prodr. **8**: 463. 1844.

Echites lasiocarpa A. DC. β. *angustifolia* (Stadelm.) A. DC. loc. cit. 1844.

Echites lasiocarpa γ. *Lobbiana* A. DC. loc. cit. 464. 1844.

Temnadenia Lobbiana (A. DC.) Miers, Apoc. So. Am. 209. 1878.

Temnadenia lasiocarpa (A. DC.) Miers, loc. cit. 210. 1878.

Suffrutescent lianas; stems terete, relatively stout, ferruginous-hispid to glabrate; leaves opposite, petiolate, obovate-elliptic, apex abruptly acuminate, base auriculate, 8–13 cm. long, 3.5–7.0 cm. broad, membranaceous, above minutely strigillose, glandular along the midrib, beneath densely tomentulose; petiole 1–3 cm. long; racemes lateral, usually somewhat shorter than the subtending leaves, bearing 5–15 showy, reddish-yellow flowers; pedicels 0.5–0.75 cm. long; bracts lanceolate, 0.2–0.5 cm. long; calyx-lobes lanceolate, acuminate, 0.4–0.5 cm. long, more or less petaloid in color and texture, variously pilose to tomentulose, the opposite, solitary squamellae trigonal-ligular; corolla infundibuliform-subsalverform, puberulent or pilose without, 2.0–2.75 cm. long, the tube about 0.3 cm. in diameter at the base, narrowing toward the insertion of the stamens, more or less gibbous, but not ventricose, somewhat inflated above the insertion of the stamens, about 0.5 cm. in diameter at the orifice, the lobes broadly and obliquely obovate, shortly acuminate, 2.0–2.25 cm. long, widely spreading; stamens inserted near the orifice of the corolla-tube; anthers auriculate, 0.5 cm. long; ovary ovoid, about

0.15 cm. long, glabrous; stigma 2 cm. long, shortly apiculate; nectaries 5, ovoid, nearly as long as the carpels; follicles relatively stout, conspicuously articulated or moniliform, 8–15 cm. long; seeds about 0.75 cm. long, the brilliant tawny coma about 1.5 cm. long.

BRAZIL: PARA: Serra de Santarem, silvula secundaria, May 13, 1927, *Ducke 21600* (B, US); MATTO GROSSO: Cuyaba, May 12, 1893, *Malme 1196*, same locality, in dumetis silvulis riparum rivularum, June 28, 1902, *Malme s. n.* (S); same locality, in silvula ripa rivulis, June 17, 1902, *Malme s. n.* (S).

Although subsequent data may prove the present plants to represent merely a variety of *M. hirsuta*, *M. lasiocarpa* possesses several distinctive characteristics which appear to entitle it to specific rank. Foremost of these is the construction of the corolla-throat, which is narrowly tubular-cylindrical, differing very markedly from that of *M. hirsuta* which is broadly conical or campanulate.

85. **Mandevilla mollissima** (HBK.) K. Sch. in Engl. & Prantl, Nat. Pflanzenfam. 4²: 171. 1895.

Echites mollissima HBK. Nov. Gen. 3: 218. 1819; A. DC. in DC. Prodr. 8: 461. 1844.

Exothostemon mollissimum (HBK.) G. Don, Hist. Dichlam. Pl. 4: 82. 1838; Miers, Apoc. So. Am. 240. 1878.

Suffruticose lianas; stems terete, relatively slender, velutinous-puberulent to glabrate; leaves opposite, petiolate, broadly ovate to ovate-oblong, rarely oblong-lanceolate, apex obtuse to abruptly acuminate, base obscurely cordate, 2–6 cm. long, 1.5–3.0 cm. broad, membranaceous, above softly velutinous to glabrate, sparsely glandular along the midrib, beneath densely tomentulose; petiole 0.2–0.5 cm. long; racemes lateral, usually somewhat shorter than the subtending leaves, bearing 4–8 reddish-yellow flowers; pedicels 0.1–0.3 cm. long; bracts narrowly lanceolate, 0.4–0.6 cm. long, scarious; calyx-lobes lanceolate, acuminate, 0.2–0.3 cm. long, scarious, puberulent to glabrate, the opposite, solitary squamellae trigonal, entire or somewhat erose; corolla typically infundibuliform, pilose to glabrate without, the proper-tube gibbous, 2.5–3.0 cm. long, about 0.15 cm. in diameter at the base, the throat conical-campanulate, 2.0–2.5 cm. long, about 1.5 cm. in diameter at the orifice, the lobes obliquely obovate,

acuminate, 2.0–2.75 cm. long, spreading; anthers auriculate, 0.7–0.8 cm. long; ovary ovoid, about 0.15 cm. long; stigma 0.2 cm. long, shortly apiculate; nectaries 5, oblongoid-ovoid, about as long as the ovary; follicles relatively stout, conspicuously moniliform, 3–9 cm. long, densely and minutely velutinous; seeds about 0.6 cm. long, the brilliant tawny coma about 1.5 cm. long.

COLOMBIA: CUNDINAMARCA: open slope above Pandi, alt. 1300–1600 m., Dec. 1–3, 1917, *Pennell 2817* (G); open loam, Fusagasuga to Pandi, alt. 1000–1300 m., Nov. 30, 1917, *Pennell 2726* (G); Callandaima & Missiones, near Bogota, April–May, *Tracey 54* (K); Bogota, March 29, 1925, *Schultze 193* (B); vicinity of Pandi, Dec., 1842, *Linden 863* (DL); TOLIMA: La Mesa, Prov. Mariquita, alt. 1300 m., 1851–57, *Triana s. n.* (BM); Dolores, alt. 1000–1200 m., date lacking, *Lehmann 7581* (FM, K, B); Honda y alrededores, March, 1868, *Stübel 74* (B); open slope, Libano, alt. 1000–1200 m., Dec. 26–29, 1917, *Pennell 3443* (G); HUILA: open rocky foothill, Cordillera Oriental, east of Neiva, alt. 600–1000 m., July 31, 1917, *Rusby & Pennell 404* (NY); open grassy slope, Cordillera Oriental, east of Neiva, Aug. 1–8, 1917, *Rusby & Pennell 1032* (NY); La Plata, date lacking, *Lehmann 704* (NY, K); VALLE DEL CAUCA: prope Cali, alt. 1030 m., April, 1876, *Andrè 2497* (K); ANTIOQUIA: Titiribi, alt. 1700 m., Aug. 31, 1930, *Archer 573* (US); NARIÑO: Prov. Pasto, alt. 1500 m., 1851–57, *Triana s. n.* (BM); MAGDALENA: prope S. Ana Nova Granatensium, date lacking, *Humboldt & Bonpland s. n.* (B); exact locality and date lacking, *Mutis 97* (Linn.).

86. **Mandevilla scabra** (R. & S.) K. Sch. in Engl. & Prantl, Nat. Pflanzenfam. 4^2: 171. 1895.

Echites scabra R. & S. Syst. 4: 795. 1819.

Echites pubiflora G. Don, Hist. Dichlam. Pl. 4: 73. 1838.

Echites Maranhamensis G. Don, *loc. cit.* 74. 1838.

Echites brachystachya Benth. in Hook. Jour. Bot. 3: 248. 1841.

Echites versicolor Stadelm. Flora 24^1: Beibl. 38. 1841; A. DC. loc. cit. 461. 1844.

Echites tenuicaulis Stadelm. loc. cit. 40. 1841; A. DC. loc. cit. 1844.

Echites Cuyabensis A. DC. loc. cit. 462. 1844.

Amblyanthera Cuyabensis (A. DC.) Muell.-Arg. in Mart. Fl. Bras. 6^1: 145. 1860.

Amblyanthera versicolor (Stadelm.) Muell.-Arg. loc. cit. 146. 1860.

Angadenia reticulata Miers, Apoc. So. Am. 179. 1878.

Mitozus versicolor (Stadelm.) Miers, loc. cit. 221. 1878.

Mitozus tenuicaulis (Stadelm.) Miers, loc. cit. 1878.
Mitozus brachystachyus (Benth.) Miers, loc. cit. 222. 1878.
Mitozus Cuyabensis (A. DC.) Miers, loc. cit. 223. 1878.
Mandevilla parvifolia K. Sch. in Engl. Bot. Jahrb. **40**: 163. 1907, nom. nud.

Suffruticose lianas; stems terete, relatively stout, puberulent or pilose to glabrate, infrequently glabrous; leaves opposite, petiolate, elliptic to oblong-elliptic, apex acute to abruptly acuminate, base rather obscurely cordate, firmly membranaceous, above softly puberulent to glabrate, infrequently glabrous, smooth, sparsely glandular along the midrib, beneath minutely tomentulose to glabrate, rarely glabrous, 4–12 cm. long, 1.5–6.0 cm. broad; petiole 0.2–0.6 cm. long; racemes lateral, bearing 3–10 showy, reddish-yellow flowers; pedicels 0.1–0.4 cm. long; bracts narrowly lanceolate, acuminate, 0.1–0.5 cm. long, scarious; calyx-lobes lanceolate to ovate-lanceolate, acuminate, 0.2–0.3 cm. long, scarious, puberulent to glabrate, infrequently glabrous, the solitary, opposite squamellae trigonal-ligular; corolla typically infundibuliform, puberulent to glabrous without, the proper-tube gibbous, 1.5–3.0 cm. long, about 0.15 cm. in diameter at the base, the throat conical, 1.25–2.0 cm. long, 1.0–1.5 cm. in diameter at the orifice, the lobes obliquely obovate, 1.5–2.0 cm. long, spreading; anthers 0.7 cm. long, auriculate; ovary ovoid, about 0.2 cm. long, glabrous or somewhat papillate; stigma 0.2 cm. long, shortly apiculate; nectaries 5, oblongoid to ovoid, about as long as the ovary; follicles slender, continuous or slightly articulated, 10–25 cm. long, glabrous or very sparsely and minutely puberulent; seeds about 0.7 cm. long, the brilliant tawny coma about 1.5 cm. long.

COLOMBIA: SANTANDER: Bucaramanga and vicinity, thickets, alt. about 1000 m., Dec. 28, 1926, *Killip & Smith 16181* (US).

VENEZUELA: BOLIVAR: Ciudad Bolivar, alt. 25 m., Nov. 4–25, 1929, *Holt & Gehriger 202* (US); AMAZONAS: Puerto Ayacucho, alt. about 100 m., May, 1931, *Holt & Blake 789* (MBG, US).

BRITISH GUIANA: dry sandstone hills, east of Rockstone, July 23–30, 1921, *Gleason 774* (G, NY); swampy banks of Cuyuni River, Kartabo, Aug. 12, 1920, *Bailey 104* (G); upper Rupununi River, near Dadanawa, lat. 2° 45′ N., July 24–29, 1922, *Cruz 1753* (FM, G, PA); Quinatta, Rupununi River, Oct., 1889, *Jenman 5550* (BM, K, NY, US); upper Rupununi River, June 10, 1867, *Appun 2351* (K); twining on bushes, Mazaruni River, Sept., 1880, *Jenman 739* (K); Savannah, Oreale, Courantyne River, Sept. 1879, *Jenman 151* (K); Demerara, date lacking, *Parker 259* (K); savannah, exact locality lacking, June, 1871, *Pollard 40* (K); junction of Mazaruni and

Cuyuni Rivers, July 18, 1924, *Graham 289* (MBG); exact locality and date lacking, *Appun 1838* (K).

French Guiana: Mana, 1856, *Sagot 386* (K); exact locality lacking, 1833, *le Prieur s. n.* (DL).

Dutch Guiana: prope Paramaribo, date lacking, *Wüllschlagel 319* (Bx, V); Zauberg, savanne, date lacking, *Pulle 78* (B); data incomplete, *Hostmann & Kappler s. n.* (B).

Brazil: para: "in vicinibus Santarem [?]," March, 1850, *Spruce s. n.* (B, BB, BM, DL, G, K); in a walk through the low grounds near the river, beyond (or N. of) Campinha, thence eastwards to the sandy high ground, and then southwestwardly into the Nazara road near the Longo de Polvora, Dec. 30, 1829, *Burchell 10026* (Bx, K); Montealegre, silva non inundata, date lacking, *Kuhlmann 21854* (B); Ilha do Mosqueiro, near Para, sandy coast, Nov. 3–9, 1929, *Killip & Smith 30422* (US); campos do Ariramba, region fl. Trombetos, Dec. 13, 1910, *Ducke 21646* (B); bahia: circa Bahiam, Aug., 1832, *Blanchet 677* (NY); Moritiba, 1841, *Blanchet 3467* (BB, NY, V); Bomfim, May 8, 1918, *Curran 158* (G); in fruticosis, 1830, *Salzmann 320* (DC, K); common about Bahia, twining among shrubs, Sept., 1837, *Gardner 894* (BM, Camb., K); 1842, *Blanchet 3637* (BM, DL, V); St. Thomas, int. Jacobina et Villanova, 1845, *Blanchet 3797* (BB, BM); date lacking, *Lhotzky 224* (B); Vittoria, Brasilia meridionalis, 1836, *Sello 212* (B); partie merid., 1840, *Blanchet 3185A* (BB, DC, DL); ceara: 1838, *Gardner 1755* (B, BB, BM, DL, K, NY, US); Guaramiranga, alt. 3000 ft., about 50 miles inland, date lacking, *Bolland s. n.* (K); near Serra do Araripe in "coapuera," April 21, 1910, *Loefgren 636* (S); Sussuanha in "coapuera," March 18, 1910, *Loefgren 339* (S); rio grande do sul: prope São Gabriel da Cachoeira, ad Rio Negro, Jan.–Aug. 1852, *Spruce 2206* (B, Bx, BB, BM, DL, G, K, V); minas geraes: Bello Horizonte, 1918, *Gehrt 3185* in part (B); amazonas: about 64° W, 30′ S., June 24, 1874, *Traill s. n.* (K); Camanãos, Rio Negro, Dec. 22, 23, 1930, *Holt & Blake 578, 593* (US); campaio, bei S. Marcos, same locality, June, 1909, *Ule 7825* (K); Ayrão, Rio Negro, June 16, 1874, *Traill 522* (K); Manãos, March 12, 1924, *Kuhlmann 21874* (B); Boa Vista, Rio Branco super., silvula secondaria, July 1913, *Kuhlmann 3645* (B); Manãos, ad margines silvarum, Jan. 16, 1924, *Kuhlmann 21855* (B); uferwald bei Boa Vista, Rio Branco, Oct., 1908, *Ule 7681* (B); Manãos, über Cachoerinha, May 21, 1903, *Goeldi 21767* (B); campanas an der Porte Negro, May, 1902, *Ule 6920* (B); São Gabriel, Rio Negro, alt. about 90 m., Dec. 1930–Jan., 1931, *Holt & Blake 614* (MBG, US); rio de janeiro: near Rio Janeiro, 1878–79, *Glaziou 11180* (K, S); Petropolis, Dec. 13, 1890, *Rudolph s. n.* (B); são paulo: Visconde do Rio Claro, Aug. 9, 1888, *Loefgren 11154* (B, S); Ubatuba, Santos, May 5, 1892, *Hoehne 11153* (B); Mogy-Mirim, in fruticeto humido scandens, March 15, 1874, *Regnell 1462* (S); maranhão: bushy places, June, 1841, *Gardner 6058* (BM, K); goyaz: Mission of Duro, Oct., 1839, *Gardner 3320* (K); Nossa Senhora d'Abadia, June, 1840, *Gardner 4271* (BM, K); matto grosso: Cataqui-Imain, Jan., 1918, *Kuhlmann 3254* (B); data incomplete: *Glaziou s. n.* (NY); *Blanchet 3023* (BM); 1842, *Blanchet 3636* (BB, BM); 1832, *Manso 2* (DC).

87. Mandevilla rugosa (Benth.) Woodson, Ann. Mo. Bot. Gard. 19: 384. 1932.

Echites rugosa Benth. in Hook. Jour. Bot. 3: 248. 1841; A. DC. in DC. Prodr. 8: 460. 1844.

Amblyanthera versicolor (Stadelm.) Muell.-Arg. *β. intermedia* Muell.-Arg. in Mart. Fl. Bras. 6¹: 146. 1860, in part.

Mitozus rugosus (Benth.) Miers, Apoc. So. Am. 222. 1878.

Suffruticose lianas; stems terete, relatively stout, pilose-puberulent to glabrate or glabrous; leaves opposite, shortly petiolate, broadly elliptic to elliptic-lanceolate, apex acute to obtuse, mucronulate, base obtuse or very obscurely cordate, 4–7 cm. long, 1.5–3.0 cm. broad, coriaceous or subcoriaceous, rugose above, finely puberulent to glabrate or glabrous, sparsely glandular along the midrib, beneath finely puberulent to tomentulose; petiole 0.5 cm. long; racemes lateral, somewhat shorter than the subtending leaves, bearing 5–18 showy, reddish-yellow flowers; pedicels 0.2–0.3 cm. long; bracts minutely ovate-lanceolate, acuminate, scarious; calyx-lobes ovate-lanceolate, acuminate, 0.1–0.15 cm. long, scarious, minutely puberulent-papillate, the opposite, solitary squamellae trigonal, minutely erose; corolla typically infundibuliform, pilosulose without, the proper-tube narrowly gibbous or arcuate, 2.5–3.0 cm. long, about 0.2 cm. in diameter at the base, the throat conical, 1.5–1.75 cm. long, about 1.5 cm. in diameter at the orifice, the lobes obliquely obovate, 1.25 cm. long, widely spreading; anthers 0.75 cm. long, auriculate; ovary ovoid-oblongoid, about 0.4 cm. long, glabrous; stigma 0.25 cm. long, obscurely apiculate; nectaries 5, about half as long as the ovary; mature follicles unknown.

British Guiana: exact locality and date lacking, *Schomburgk 350* (B, BB, BM, DC, K, type, MBG, photograph and analytical drawings); upper Rupununi River, near Dadanawa, lat. 2° 45′ N., July 24–29, 1922, *Cruz 1753* (G).

Brazil: para: date lacking, *Wullschlägel 1506* (V); bahia: Bomfim, May 8, 1918, *Curran 158* (G); exact locality and date lacking, *Tamberlik s. n.* (V, MBG, photograph).

88. **Mandevilla symphitocarpa** (G. F. W. Mey.) Woodson, Ann. Mo. Bot. Gard. 19: 70. 1932.

Echites symphitocarpa G. F. W. Mey. Prim. Fl. Esseq. 132. 1818; A. DC. in DC. Prodr. 8: 467. 1844.

Mitozus symphitocarpus (G. F. W. Mey.) Miers, Apoc. So. Am. 222. 1878.

Suffruticose lianas; stems terete, relatively stout, glabrous, infrequently somewhat puberulent to glabrate; leaves opposite,

petiolate, ovate- to oblong-lanceolate, apex acute to acuminate, base cordate, 8–15 cm. long, 3–6 cm. broad, firmly membranaceous, above glabrous, glandular along the midrib, beneath glabrous, infrequently somewhat puberulent to glabrate; petioles 0.5–1.25 cm. long; racemes lateral, about as long as the subtending leaves, bearing 5–20 showy, yellow, reddish-flushed flowers; pedicels 0.3–0.5 cm. long; bracts lanceolate, 0.1–0.4 cm. long, scarious; calyx-lobes lanceolate, acuminate, 0.3–0.5 cm. long, scarious, glabrous, the opposite, solitary squamellae trigonal, entire or somewhat erose; corolla typically infundibuliform, glabrous without, the proper-tube gibbous, 3.0–3.5 cm. long, about 0.2 cm. in diameter at the base, the throat conical, 3.0–3.5 cm. long, about 2 cm. in diameter at the orifice, the lobes obliquely obovate, 2.75–3.0 cm. long, spreading; anthers 0.7–0.8 cm. long, auriculate; ovary oblongoid-ovoid, about 0.3 cm. long, glabrous; stigma 0.2 cm. long, shortly apiculate; nectaries 5, ovoid, about as long as the ovary; mature follicles unknown.

BRITISH GUIANA: Mt. Everard, Northwest District, Febr. 12, 1922, *Cruz 1299* (NY); Anabisi River, Northwest District, Febr. 15, 1922, *Cruz 1347* (NY); Penal Settlement, May, 1905, *Waly 8362* (NY); Anabisi River, Northwest District, Febr. 14, 1922, *Cruz s. n.* (NY); exact locality lacking, 1916, *Taylor s. n.* (NY); Upper Rupununi River, near Dadanawa, lat. 2° 45′ N., June 13, 1922, *Cruz 1474* (NY); sandy soil, bank of canal, Covenden, Demerara River, Febr. 2, 1923, *Persaud 74* (FM).

FRENCH GUIANA: le Mana, 1856, *Sagot 886* (K, V).

DUTCH GUIANA: near the 2n or Oude Ryweg, Paramaribo, May 23, 1916, *Samuels 457* (NY, K).

TRINIDAD: Irois, March, 1888, *Crueger 39* (B, K); Erin, near the sea, Febr. 7, 1908, *Broadway 2644* (B); Cap-de-Ville road, five miles from Erin, March 27, 1908, *Broadway 2228* (B); Cap-de-Ville, Nov. 14, 1915, *Broadway 7369* (NY).

89. **Mandevilla leptophylla** (A. DC.) K. Sch. in Engl. & Prantl, Nat. Pflanzenfam. 4²: 171. 1895.

Echites linearifolia Stadelm. Flora 24¹: Beibl. 18. 1841, not Ham.

Echites leptophylla A. DC. in DC. Prodr. 8: 455. 1844.

Mitozus leptophyllus (A. DC.) Miers, Apoc. So. Am. 220. 1878.

Mandevilla linearis N. E. Br. Trans. Linn. Soc. Bot. II. 6: 48. 1901.

Suffruticose lianas; stems terete, relatively slender, puberulent

to glabrate; leaves opposite, petiolate, linear to linear-elliptic, apex acuminate, base gradually attenuate, rarely obscurely cordate, 3–7 cm. long, 0.2–0.6 cm. broad, firmly membranaceous to subcoriaceous, above glabrous, sparsely glandular along the midrib, beneath finely puberulent; petiole 0.2–0.3 cm. long; racemes lateral, somewhat shorter than the subtending leaves, bearing 1–4 showy, reddish-yellow flowers; pedicels 0.1–0.3 cm. long; bracts narrowly lanceolate, 0.1–0.4 cm. long, scarious; calyx-lobes ovate to ovate-lanceolate, 0.1–0.2 cm. long, scarious, glabrous to sparsely puberulent-papillate, the opposite, solitary squamellae trigonal-ligular; corolla typically infundibuliform, glabrous or somewhat pilosulose without, the proper-tube gibbous, 2.0–2.5 cm. long, about 0.15 cm. in diameter at the base, the throat rather narrowly conical, 1.5–2.0 cm. long, about 1 cm. in diameter at the orifice, the lobes obliquely obovate, 1.75–2.25 cm. long, spreading; anthers 0.7 cm. long, auriculate; ovary ovoid-oblongoid, about 0.2 cm. long; stigma 0.2 cm. long, shortly apiculate; nectaries 5, ovoid-oblongoid, about as long as the ovary; follicles slender, conspicuously articulated or moniliform, 10–15 cm. long; seeds about 0.8 cm. long, the brilliant tawny coma about 1.5 cm. long.

British Guiana: Mt. Roraima, humid, sloping, deeply shaded ground in the Weitipu Forest, Arabupu, alt. 4200 ft., Jan. 1, 1928. *Tate 228* (K, NY); Kotinga Valley, 1894, *Quelch & McConnell 132, 194* (K); Rupununi, Jan., 1842, *Schomburgk 383* (B).

Brazil: amazonas: Serra de Mairary, Surumu, Rio Branco, alt. 900–1200 m., Sept., 1909, *Ule 8450* (K, B).

90. Mandevilla rutila Woodson, Ann. Mo. Bot. Gard. **19**: 385. 1932.

Suffruticose lianas; stems terete, relatively slender, softly ferruginous-pilosulose to glabrate; leaves opposite, petiolate, elliptic to elliptic-obovate, apex acuminate, base obscurely auriculate, 8–15 cm. long, 3–5 cm. broad, membranaceous, above somewhat ferruginous-pilose and glandular along the midrib, beneath pale ferruginous- or yellowish-pilosulose; petiole 0.5–1.0 cm. long; racemes lateral, usually somewhat shorter than the subtending leaves, bearing 10–25 showy, reddish-yellow flowers; pedicels 0.3–0.5 cm. long; bracts linear or filiform, about 1 cm.

long; calyx-lobes ovate-lanceolate, long-acuminate, 0.2–0.4 cm. long, scarious, the opposite, solitary squamellae deltoid, somewhat lacerate; corolla typically infundibuliform, rather sparsely pilose without, the proper-tube more or less gibbous or arcuate toward the insertion of the stamens, 1.75–2.25 cm. long, about 0.15 cm. in diameter at the base, the throat conical-campanulate, 1.0–1.5 cm. long, 0.8–1.0 cm. in diameter at the orifice, the lobes obliquely obovate, shortly acuminate, 1.2–1.8 cm. long, widely spreading; anthers 0.4 cm. long, auriculate; ovary ovoid, about 0.15 cm. long, glabrous; stigma 0.2 cm. long, shortly apiculate; nectaries 5, oblongoid, about half as long as the ovary; follicles relatively slender, conspicuously articulated, 15–20 cm. long; seeds 0.5 cm. long, the brilliant tawny coma 2 cm. long.

Bolivia: la paz: Mapiri, alt. 5000 ft., April 1886, *Rusby 2385* (NY, type, MBG, photograph and analytical drawings); Hacienda Simaco, sobre el camino a Tipuani, alt. 1400 m., Jan., 1920, *Buchtien 5100* (G, US); Hacienda Casana, sobre el camino a Tipuani, alt. 1400 m., Sept. 8, 1923, *Buchtien 7441* (US); Mapiri region, San Carlos, am wege nach San Jose, alt. 800 m., Jan. 29, 1927, *Buchtien 1197* (US).

91. **Mandevilla Fendleri** (Muell.-Arg.) Woodson, Ann. Mo. Bot. Gard. **19**: 70. 1932.

Amblyanthera Fendleri Muell.-Arg. Linnaea **30**: 417. 1860; Miers, Apoc. So. Am. 190. 1878.

Suffruticose lianas; stems terete, relatively stout, finely velutinous to glabrate; leaves opposite, shortly petiolate, narrowly elliptic- or linear- to ovate-lanceolate, apex acuminate, base rather obscurely cordate, 5–12 cm. long, 1.5–6.0 cm. broad, firmly membranaceous, above minutely puberulent to glabrate, sparsely glandular along the midrib, beneath minutely velutinous to glabrate; petiole 0.5–2.0 cm. long; racemes lateral, somewhat shorter than the subtending leaves, bearing 3–8 showy, reddish-yellow flowers; pedicels 0.2–0.4 cm. long; bracts narrowly lanceolate, 0.2–0.5 cm. long, scarious; calyx-lobes lanceolate, acuminate, 0.2–0.3 cm. long, scarious, minutely puberulent, the opposite, solitary squamellae trigonal-ligular; corolla typically infundibuliform, pilose without, the proper-tube gibbous, 1.0–2.25 cm. long, about 0.15 cm. in diameter at the base, the throat narrowly campanulate, 1.5–2.5 cm. long, about 1.0–1.25 cm. in diameter at the orifice, the lobes obliquely obovate, 1.5–2.25 cm. long,

spreading; anthers 0.7 cm. long, auriculate; ovary ovoid, about 0.2 cm. long, shortly apiculate; nectaries 5, compressed-ovoid, about as long as the ovary; follicles relatively slender, moniliform, 10–20 cm. long, minutely puberulent to glabrate, infrequently glabrous; seeds 0.8 cm. long, the brilliant-tawny coma about 1.5 cm. long.

COLOMBIA: SANTANDER: woods, vicinity of California, alt. 2300 m., Jan. 11–27, 1927, *Killip & Smith 17054* (AA, US); open hillside, between Piedecuesta and Las Vegas, alt. 1200–2000 m., Dec. 19, 1926, *Killip & Smith 15469* (US); META: Villavicencio, Jan., 1876, *André 1173* (K); CUNDINAMARCA: Ubala, Prov. Bogota, Oct., 1855, *Triana s. n.* (BM); Pacho, alt. 1500–2000 m., Jan., 1892, *Lehmann 7580* (B); JURADO: clearing, La Cumbre, El Valle, alt. 1600–2000 m., May 12–18, 1922, *Pennell 5405* (B, NY, US); thicket, La Cumbre, El Valle, alt. 1600–2100 m., Sept. 25–27, 1922, *Killip 11602* (G, US); wayside, La Cumbre, El Valle, alt. 1600–1800 m., Sept. 10, 1922, *Hazen & Killip 11168* (NY); CALDAS: thickets, San Jose, alt. 1500–1800 m., Sept. 3, 1922, *Pennell 10231* (NY); moist rill-bank, northeast of Armenia, alt. 1300–1500 m., July 24–25, 1922, *Pennell, Killip & Hazen 8686* (NY); dry open wayside, Supia, alt. 1200–1500 m., Sept. 18, 1922, *Pennell 10703* (G); ANTIOQUIA: Titiribi, vicinity of Medellin, Aug. 20, 1927, *Toro 391* (NY); Angeliopolis, vicinity of Medellin, Jan. 22, 1928, *Toro 928* (NY); moist bank, north of Caramanta, alt. 2000–2200 m., Sept. 19, 1922, *Pennell 10783* (G, US); bushy slopes of hill west of Paso de Caramanta, Rio Cauca, alt. 700–1000 m., Sept. 20, 1922, *Pennell 10820* (G, US).

VENEZUELA: MERIDA: prope coloniam Tovar, 1854–55, *Fendler 1032* (Bx, BB, TYPE, K, MBG); in nemor. subalpinis, exact locality and date lacking, *Moritz 1899* (BM, K, V).

92. **Mandevilla Schlimi** (Muell.-Arg.) Woodson, Ann. Mo. Bot. Gard. **19**: 70. 1932 (as *M. Schlimii*).

Amblyanthera Schlimi Muell.-Arg. Linnaea **30**: 419. 1860; Miers, Apoc. So. Am. 189. 1878.

Suffruticose lianas; stems terete, relatively slender, minutely puberulent to glabrate; leaves opposite, shortly petiolate, narrowly elliptic-lanceolate, apex acuminate, base attenuate and somewhat decurrent, 3–6 cm. long, 0.5–1.0 cm. broad, subcoriaceous, above glabrous and somewhat rugose, beneath minutely and densely puberulent; petiole 0.3–0.5 cm. long; racemes lateral, somewhat shorter than the subtending leaves, bearing 3–8 showy, reddish-yellow flowers; pedicels 0.1–0.2 cm. long; bracts lanceolate, 0.1–0.2 cm. long, scarious; calyx-lobes lanceolate- to ovate-trigonal, 0.1–0.2 cm. long, scarious, minutely puberulent to glabrate, the opposite, solitary squamellae trigonal-ligular; corolla typically infundibuliform, minutely puberulent to glabrate without, the proper-tube gibbous, 1.0–1.25 cm. long, about

0.15 cm. in diameter at the base, the throat narrowly campanulate, 1.0–1.25 cm. long, about 0.75 cm. in diameter at the orifice, the lobes obliquely obovate, 1.0 cm. long, spreading; anthers 0.6 cm. long, auriculate; ovary ovoid, about 0.15 cm. long, glabrous; stigma 0.2 cm. long, shortly apiculate; nectaries 5, ovoid-oblongoid, somewhat shorter than the ovary; follicles unknown.

Colombia: santander del norte: Ocaña, alt. 6000 ft., May, 1846–52, *Linden 575* (BB, type, Bx, K, MBG, photograph and analytical drawings); Rio Frio, alt. 7000–8000 ft., Jan. 17, 1881, *Kalbreyer 1955* (B, K); cundinamarca: Gachala & Ubala, alt. 1000 m., Prov. Bogota, 1851–1857, *Triana s. n.* (BM).

93. **Mandevilla Trianae** Woodson, Ann. Mo. Bot. Gard. **19**: 70. 1932.

Suffruticose lianas; stems terete, relatively slender, softly puberulent-hirtellous to glabrate; leaves opposite, shortly petiolate, ovate to broadly ovate-lanceolate, apex acute to acuminate, base narrowly cordate, 6–12 cm. long, 2–4 cm. broad, membranaceous, above minutely puberulent to glabrate, glandular along the midrib, beneath puberulent; petiole 0.3–0.6 cm. long; racemes lateral, equalling or slightly surpassing the subtending leaves, bearing 6–10 showy, reddish-yellow flowers; pedicels 0.4–0.6 cm. long; bracts lanceolate, 0.4–0.5 cm. long, scarious; calyx-lobes lanceolate, acuminate, 0.1–0.2 cm. long, scarious, minutely puberulent, the opposite, solitary squamellae deltoid, minutely erose; corolla typically infundibuliform, minutely puberulent to glabrate without, the proper-tube gibbous, 1.75–2.0 cm. long, about 0.15 cm. in diameter at the base, the throat narrowly campanulate, 1.5–1.75 cm. long, about 0.7 cm. in diameter at the orifice, the lobes obliquely obovate, 1.5 cm. long, spreading; anthers 0.4 cm. long, auriculate; ovary oblongoid, about 0.15 cm. long, minutely puberulent; stigma 0.2 cm. long, shortly apiculate; nectaries 5, oblongoid, about half as long as the ovary; follicles unknown.

Colombia: choco: exact locality lacking, alt. 150 m., April, 1853, *Triana 3409* (BM, type, MBG, photograph and drawings); valle del cauca: Cordoba, Dagua Valley, Pacific Coastal Zone, alt. 30–100 m., Dec., 1905, *Pittier 520* (US).

Ecuador: Cuza, in Andib. sept. Republicae Equator, alt. 2875 m., June, 1876, *Andrè 3590* (K).

Peru: junin: on sunny brush, La Merced, Hacienda Schunke, alt. about 4000 ft., Aug. 27–Sept. 1, 1923, *Macbride 5812* (FM).

94. Mandevilla scaberula N. E. Br. Trans. Linn. Soc. Bot. II. 6: 48. 1901.

Suffruticose lianas; stems terete, relatively stout, densely puberulent to glabrate; leaves opposite, petiolate, oblong to oblong-elliptic, apex acute to abruptly acuminate, infrequently obtuse, base broadly and rather obscurely cordate, 5–12 cm. long, 2.5–5.0 cm. broad, coriaceous, above scabrous and minutely strigillose, glandular along the midrib, beneath densely tomentulose; petiole 0.3–0.5 cm. long; racemes lateral, somewhat longer than the subtending leaves, bearing 10–30 showy, reddish-yellow flowers; pedicels 0.4–0.6 cm. long; bracts ovate, 0.15–0.3 cm. long, scarious; calyx-lobes ovate-reniform, broadly obtuse or rounded, 0.15–0.2 cm. long, scarious, minutely hispid, the opposite, solitary squamellae trigonal-ligular; corolla typically infundibuliform, minutely puberulent without, the proper-tube slightly gibbous or arcuate, 2.5–3.0 cm. long, about 0.2 cm. in diameter at the base, the throat conical, 1.5–2.0 cm. long, about 1 cm. in diameter at the orifice, below obliquely obovate, 1.5 cm. long, spreading; anthers about 0.5 cm. long, auriculate; ovary ovoid, about 0.15 cm. long, puberulent-papillate; stigma 0.15 cm. long, shortly apiculate; nectaries 5, ovoid, about half as long as the ovary; follicles relatively stout, rather distinctly articulated, 12–15 cm. long, minutely hirtellous; seeds about 0.8 cm. long, the brilliant tawny coma about 1.5 cm. long.

British Guiana: Tolimbaru Creek, near Roraima, autumn, 1894, *Quelch & McConnell 146* (K, type, MBG, photograph and drawings).

Brazil: amazonas: Serra de Mairary, Rio Branco, Febr., 1909, *Ule 8449* (B).

95. Mandevilla bracteata (HBK.) O. Ktze. Rev. Gen. 2: 414. 1891.

Echites bracteata HBK. Nov. Gen. 3: 217. 1819, not Vell.

Exothostemon bracteatum (HBK.) G. Don, Hist. Dichlam. Pl. 4: 82. 1838.

Mandevilla attenuata Rusby, Descr. So. Am. Pl. 89. 1920.

Suffruticose lianas; stems terete, relatively stout, densely puberulent-tomentulose to glabrate; leaves opposite, petiolate, ovate-lanceolate, apex acuminate, base obscurely cordate, 4–10 cm. long, 1.5–3.5 cm. broad, membranaceous, above puberulent to glabrate, not strigillose, glandular along the midrib, beneath

tomentulose; petioles 0.4–1.0 cm. long; racemes lateral, about as long as the subtending leaves, bearing 10–30 showy, reddish-yellow flowers; pedicels 0.3–0.5 cm. long; bracts ovate to ovate-lanceolate, sessile, 1–3 cm. long, petaloid, usually highly colored, puberulent; calyx-lobes lanceolate, acuminate, 0.6–0.7 cm. long, scarious, puberulent-glabrate, the opposite solitary squamellae trigonal, entire or slightly erose; corolla typically infundibuliform, puberulent without, the proper-tube slightly gibbous or arcuate, particularly before the expansion of the bud, 2–3 cm. long, about 0.15 cm. in diameter at the base, the throat conical, 1.5–2.0 cm. long, about 1 cm. in diameter at the orifice, the lobes obliquely obovate to obovate-oblong, spreading, 1.5–2.5 cm. long; anthers 0.6 cm. long, auriculate; ovary ovoid, about 0.15 cm. long, minutely papillate; stigma 0.2 cm. long, shortly apiculate; nectaries 5, compressed-obovoid, about half as long as the ovary; follicles relatively slender, distantly articulate, densely and minutely puberulent, 10–15 cm. long; seeds about 0.6 cm. long, the brilliant tawny coma about 1.5 cm. long.

COLOMBIA: CAUCA: near the small village of Chisques, Prov. of Popayan, date lacking, *Humboldt & Bonpland* (K, MBG, photograph); VALLE DEL CAUCA: open hillsides east of Dagua, alt. 1200–1500 m., May 13–14, 1922, *Pennell 5604* (NY); near El Carmen, Dagua Valley, Western Cordillera, alt. 1500 m., Dec. 11, 1905, *Pittier 611* (US); ANTIOQUIA: occasional in clearings and on the edge of forest near Las Partidas and Valparaiso, alt. 3500 ft., June 2, 1899, *H. H. Smith 1663* (FM, G, K, MBG, NY, US).

ECUADOR: PICHINCHA: Quito, date lacking, *Karsten s. n.* (V).

96. **Mandevilla hirsuta** (A. Rich.) K. Sch. in Engl. & Prantl, Nat. Pflanzenfam. 4²: 171. 1895.

Echites hirsuta A. Rich. Actes Soc. Hist. Nat. Paris **1**: 107. 1792, not R. & P.; A. DC. in DC. Prodr. **8**: 463. 1844.

Echites tomentosa Vahl, Symb. Bot. 3: 44. 1794; A. DC. loc. cit. 463. 1844.

Echites macrophylla HBK. Nov. Gen. **3**: 218. 1819, not Roxb.

Echites campestris Vell. Fl. Flum. 113. 1830; Icon. **3**: *pl. 43*. 1827.

Echites Richardi R. & S. Syst. **4**: 391. 1819.

Exothostemon macrophyllum (HBK.) G. Don, Hist. Dichlam. Pl. **4**: 82. 1838.

Echites hispida Willd. ex R. & S. loc. cit. 795. 1819; A. DC. loc. cit. 475. 1844.

Echites auriculata Pohl, ex Stadelm. Flora 24[1]: Beibl. 25. 1841; A. DC. loc. cit. 459. 1844.

Echites hirsuta R. & P. α. *latifolia* Stadelm. loc. cit. 27. 1841.

Echites almadensis Stadelm. loc. cit. 28. 1841; A. DC. loc. cit. 464. 1844.

Echites Stadelmeyeri Mart. ex Stadelm. loc. cit. 29. 1841; A. DC. loc. cit. 1844.

Echites ciliata Stadelm. loc. cit. 32. 1841; A. DC. loc. cit. 459. 1844.

Echites Fluminensis A. DC. loc. cit. 452. 1844.

Echites Fluminensis A. DC. β. *Claussenii* A. DC. loc. cit. 1844.

Echites tomentosa Vahl β. *laticordata* A. DC. loc. cit. 463. 1844.

Amblyanthera ciliata (Stadelm.) Muell.-Arg. in Mart. Fl. Bras. 6[1]: 145. 1860; Miers, Apoc. So. Am. 188. 1878.

Amblyanthera palustris Muell.-Arg. loc. cit. 1860.

Echites palustris Salzm. ex Muell.-Arg. loc. cit. 146. 1860; nom. nud. in synon.

Amblyanthera palustris Muell.-Arg. β. *almadensis* (Stadelm.) Muell.-Arg. loc. cit. 1860.

Amblyanthera hispida (R. & S.) Muell.-Arg. loc. cit. 147. *t. 44. fig. 2.* 1860; Miers, loc. cit. 187. 1878.

Amblyanthera hispida (R. & S.) Muell.-Arg. β. *tomentosa* Muell.-Arg. loc. cit. 148. *t. 44. fig. 3.* 1860.

Amblyanthera fluminensis (A. DC.) Muell.-Arg. loc. cit. 1860; Miers, loc. cit. 186. 1878.

Amblyanthera fluminensis (A. DC.) Muell.-Arg. β. *Claussenii* A. DC. ex Muell.-Arg. loc. cit. 149. 1860.

Amblyanthera fluminensis (A. DC.) Muell.-Arg. α. *Stadelmeyeri* (Mart.) Muell.-Arg. loc. cit. 1860.

Amblyanthera campestris (Vell.) Muell.-Arg. loc. cit. 149. 1860.

Rhabdadenia campestris (Vell.) Miers, loc. cit. 121. 1878.

Amblyanthera hirsuta (Vell.) Miers, loc. cit. 185. 1878.

Amblyanthera Claussenii (A. DC.) Miers, loc. cit. 187. 1878.
Amblyanthera ovata Miers, loc. cit. 188. 1878.
Temnadenia pallidiflora Miers, loc. cit. 211. 1878, not *Echites Franciscea* Hook. var. *pallidiflora* Hook.
Temnadenia palustris (Salzm.) Miers, loc. cit. 213. 1878.
Temnadenia tomentosa (Vahl) Miers, loc. cit. 1878.
Mandevilla hispida (R. & S.) Hemsl. Biol. Centr.-Am. Bot. **2**: 316. 1882.
Mandevilla palustris (Muell.-Arg.) Hemsl. loc. cit. 317. 1882.
Mandevilla tomentosa (Vahl) O. Ktze. Rev. Gen. **2**: 416. 1891.
Mandevilla tomentosa (Vahl) O. Ktze. var. *Vahleana* O. Ktze. loc. cit. 1891.
Mandevilla tomentosa (Vahl) O. Ktze. var. *hirsuta* (Rich.) O. Ktze. loc. cit. 1891.
Mandevilla tomentosa (Vahl) O. Ktze. var. *hispida* (R. & S.) O. Ktze. loc. cit. 1891.
Mandevilla fluminensis (A. DC.) Donn. Sm. Enum. Pl. Guat. **2**: 47. 1891.
Mandevilla auriculata (Stadelm.) K. Sch. loc. cit. 1895.
Mandevilla tomentosa (Vahl) K. Sch. loc. cit. 1895.
Mandevilla Rusbyi Britton, Bull. N. Y. Bot. Gard. **4**: 409. 1907.
Mandevilla denticulata S. F. Blake, Contr. Gray Herb. **52**: 81. 1917.

Suffruticose lianas; stems terete, relatively stout, hispid to glabrate; leaves opposite, petiolate, obovate- to oblong-elliptic, apex rather abruptly acuminate, base obscurely auriculate, 5–20 cm. long, 2–8 cm. broad, membranaceous, above strigillose, glandular along the midrib, beneath minutely tomentulose; petiole 0.1–0.4 cm. long; racemes lateral, equalling or somewhat surpassing the subtending leaves, bearing 5–25 showy, reddish-yellow flowers; pedicels 0.2–0.5 cm. long; bracts ovate to ovate-lanceolate, sessile, 0.5–2.0 cm. long, petaloid; calyx-lobes lanceolate to ovate-lanceolate, 0.5–1.0 cm. long, scarious or somewhat petaloid, hispidulous, the opposite, solitary squamellae trigonal-ligular, entire or somewhat erose; corolla typically infundibuli-

form, puberulent or pilose without, the proper-tube somewhat gibbous, 2.0–3.5 cm. long, about 0.2 cm. in diameter at the base, the throat conical or conical-campanulate, 1.5–2.0 cm. long, about the same in diameter at the orifice, the lobes obliquely obovate, 1.5–1.75 cm. long, spreading; anthers 0.5 cm. long, auriculate; ovary ovoid, about 0.12 cm. long, glabrous or papillate; stigma 0.2 cm. long, shortly apiculate; nectaries 5, compressed-obovoid, about half as long as the ovary; follicles stout, conspicuously articulated or moniliform, 6–15 cm. long; seeds 0.8 cm. long, the brilliant tawny coma about 1.5 cm. long.

British Honduras: swampy thicket, New Haven, March 8, 1907, *Peck 696* (G); Middlesex, secondary forest, alt. 200 ft., Sept. 14, 1929, *Schipp 56* (FM, G, NY).

Guatemala: alta verapaz: Rio Chacate, alt. 1300 pp., April, 1889, *J. D. Smith 1746* (US); eastern portions of Vera Paz and Chiquimala, 1885, *Watson 379b* (G); Sehachicha, alt. 500 m., March, 1902, *Tuerckheim 8244* (B, G, US); vicinity of Secanquim, alt. 550 m., May 20, 1905, *Pittier 203* (US); Secanquim, near the Finca Sepacuite, March 29, 1902, *Cook & Griggs 273* (US); between Sepacuite and Secoyocte, alt. 1100 m., May 24, 1905, *Pittier 343* (US); Finca Mocca, alt. 1800 ft., Dec. 4, 1919, *Johnson 89* (NY, US); izabal: Puerto Barrios, Febr. 25, 1905, *Deam 3* (G, NY); May 10–18, 1919, *Pittier 8540* (US); in swamp, vicinity of Puerto Barrios, at sea level, June 2–6, 1922, *Standley 25027* (G, US).

Costa Rica: guanacaste: bord de la route à Corralillo, May 12, 1890, *Pittier 2498* (Bx); puntarenas: broussailles à General, Febr., 1891, *Pittier 4002* (Bx, BB, US); buissons de Boruca, Dec., 1891, *Pittier s. n.* (Bx); san jose: La Laguna, date lacking, *Wercklè 71* (B); limon: bord du Rio Amarillo, Santa Clara, alt. 200 m., July 22, 1891, *Pittier 13436* (US); Jimenez, Llanuras de Santa Clara, alt. 250 m., Febr., 1896, *J. D. Smith 6657* (US); same locality, April, 1894, *J. D. Smith 4884* (B, BM, G, K, US); data incomplete: Aug., 1875, *Endres 235* (K).

Nicaragua: chontales: in the vicinity of San Juan del Norte (Greytown), Jan., 1896, *C. L. Smith 71* (US); data incomplete: 1867, *Tate 235* (BM, K).

Panama: colon: between France Field, C. Z., and Catival, Jan. 9, 1924, *Standley 30385* (US); Santa Rita Trail, Febr. 27, 1905, *Cowell 134* (NY); chiriqui: vicinity of San Felix, alt. 0–120 m., Jan., 1912, *Pittier 5460* (US); cocle: above Penonome, March 5–10, 1908, *Williams 547* (NY); bocas del toro: lower Changuinola River, July–Aug., 1923, *Stork 270* (US); panama: vicinity of La Palma, southern Darien, alt. 0–50 m., Jan.–Febr., 1912, *Pittier 5490* (US); in a wet ravine, near Panama, out on the railroad, May 13, 1862, *Hayes s. n.* (BM); canal zone: between Chagres Batteries and Fort San Lorenzo, Fort Sherman Military Reservation, June 14, 1923, *Maxon & Valentine 6972* (US); mouth of the Rio Chagres, near Old Fort Lorenzo, March 8, 1923, *Piper 5914* (US); Gatun Sta., Oct., 1859, *Hayes 167* (NY); same locality, Oct. 28, 1859, *Hayes 98* (G); near Fort Randolph, May 26, 1923, *Maxon & Harvey 6527* (US).

Colombia: valle del cauca: cliffs along Rio Dagua, alt. 80–100 m., near Cordoba, Oct. 9, 1922, *Killip 11775* (NY); Cordoba, Dagua Valley, Pacific Coastal Zone, alt. 30–100 m., Dec., 1905, *Pittier 555* (US); santander del norte: Ocaña to Pamplona, open spaces, alt. 3000 ft., Dec. 18, 1876, *Kalbreyer 837* (B, K); department uncertain: Lusumucu, alt. 1165 m., Jan. 12, 1876. *Andrè 1942* (K).

VENEZUELA: data incomplete, 1868, *Stevens s. n.* (NY).

TRINIDAD: forest border, Aripo Savanna, March 5, 1920, *Britton, Broadway & Hazen 310* (G, NY, US); Brighton, June 17, 1903, *Johnston 92* (G, NY); forest, Brazil, March 6, 1921, *Britton Britton & Freeman 2135* (G, NY, US); Aripo road via Arima, near 3 Mile Post, climbing over shrubs, Oct. 16, 1925, *Broadway s. n.* (K, MBG); Santa Cruz, roadside leading to Providence Estate, May 20, 1908, *Broadway 2592* (B, FM); Cakaden, April, 1874, *Kuntze 856* (NY); Aripo Savannah, April 26, 1924, *Broadway s. n.* (FM); Spring Hill, near Scarborough, Jan. 11, 1910, *Broadway 3375* (B, MBG); Tobago, Oct., 1889, *Eggers 5546* (B, C, K, US); in fruticosis ad Arima, Dec., 1883, *Eggers 1155* (B, K, US, V); Port-of-Spain, Aug. 2, 1899, *Preuss 1462* (B); King's Bay, March 22, 1896, *Seitz 14* (B); Tobago, date lacking, *Hamilton s. n.* (DL); exact locality lacking, April 4, 1874, *Kuntze 601* (FM, NY); exact locality and date lacking, *Sieber 333* (DC, DL, MBG, V); data incomplete: 1877–80, *Fendler 624* (K); Sept. 14, 1842, *Crueger s. n.* (K).

BRITISH GUIANA: Kamakusa, upper Mazuruni River, longitude about 59° 50′ W., July 11–22, 1923, *Cruz 4154* (FM, MBG, PA, US); Pomeroon River, Pomeroon District, Dec. 17–24, 1922, *Cruz 3100* (FM, G); Morawhanna, Barima River, Jan. 14, 1920, *Hitchcock 17500* (G, NY, US); East Coast Water Conservancy, southeast of Georgetown; canal southeast of Lamaha Stop-off, Nov. 27, 1919, *Hitchcock 16972* (G); Bartica, on the Essequibo River, Nov., 1888, *Jenman 4726* (BM, K, NY); vicinity of Bartica, on the Essequibo River, Sept. 3–12, 1922, *Cruz 1990* (FM, MBG, NY, US); Essequibo River, Sept.–Oct., year lacking, *Jenman 1313* (K); Courantyne River, Oct., 1879, *im Thurn s. n.* (K); above Barakara, Dec. 26, 1914, *Hohenkerk 680* (K); Epruo, Courantyne River, Oct., 1879, *Jenman 447* (K); Lamaha, April, 1887, *Jenman 3867* (K); Pomeroon River, Sept., 1904, *Bartlett 8007* (B); data incomplete: *Parker s. n.* (K); *Schomburgk 130* (B).

DUTCH GUIANA: ad aquas prope urbem Paramaribo, March–April, 1844, *Kappler 1605* (BB, MBG, S); Mosquitokuste, date lacking, *Wullschlägel s. n.* (V); Republick, savanne, Oct. 13, 1911, *Kuyper 39* (B); Paramaribo, date lacking, *Wullschlägel 320* (V); in umbrosis prope Paramaribo, Dec., 1837, *Splitgerber s. n.* (V); data incomplete, *Hostmann 946* (K, NY, U).

FRENCH GUIANA: vicinity of Cayenne, July 14, 1921, *Broadway 826* (US); Cayenne 1835, *le Prieur s. n.* (K); Karouany, 1836, *Sagot 381* (BB, BM, K, S, V); Cayenne, 1819, *Perrottet 272* (DL); Cayenne, 1835, *le Prieur s. n.* (DL); data incomplete: July, 1824, *Poiteau s. n.* (K); 1792, *le Blond 387* (DL); 1819–21, *Poiteau s. n.* (DL); *le Prieur 244* (DL); 1802, *Gabriel s. n.* (DL).

BRAZIL: PARA: at Para, in a walk between S. Jose and the arsenal, 20 Aug., 1829, *Burchell 9550* (K); at the village of Sta. Anna, 7 June, 1829, *Burchell 9356* (K); Para, 1916, *Moss s. n.* (BM); vicinity of Para, Jan., 1908, *Baker 165* (BM); thickets, Para, Oct. 27–Nov. 7, 1929, *Baker 165* (BM); thickets, Para, Oct. 27–Nov. 7, 1929, *Killip & Smith 30257* (MBG, US); in open field on low land, Campo de Boa Esperanca, Maracassume River region, Sept. 1, 1932, *Krukoff 1854* (MBG, NY); in thickets, near Para, July, 1849, *Spruce 229* (K); SÃO PAULO: level sandy soil covered with Capoeiro and forest, in a walk from the outeirinhos to the town (Santos), Oct. 18, 1826, *Burchell 3255* (Bx, NY); S. Vicente, Nov. 18, 1898, *Loefgren 1141* (B); MARANHÃO: Cururupu, Aug. 1914, *Lisboa 4786* (B); MINAS GERAES: Jan. 21, 1861, *Regnell 189* (B, K, S, US); 1841, *Claussen 1369* (NY); Aug.–April, 1840, *Claussen 250* (Bx, K, S); Caxoeira, date lacking, *Claussen 190* (Bx, DL); Congonhas do Campo, 1893, *Stephan s. n.* (Bx); 1875, *Widgren 61* (Bx, S); Bello Horizonte, Dec. 15, 1918, *Hoehne*

3185 (B); in campo, Nov. 24, 1905, *Sampaio 238* (B); Caete, Nov., 1915, *Hoehne 6633* (B); RIO DE JANEIRO: near Rio de Janeiro, date lacking, *Glaziou 8796* (Bx, K, US); Rio de Janeiro, 1878–79, *Glaziou 11195* (B, K); Rio de Janeiro, Nov., 1897, *Ule 4580* (B); Rio de Janeiro, date lacking, *Sello 170* (B); near Mage, on the flat between the head of the bay of Rio and the Organ Mts., March, 1837, *Gardner 535* (K); Mage, March, 1838, *Miers 4022* (BM); Mage to Freichal, Jan. 15, 1838, *Miers 4031* (BM); PERNAMBUCO: roadside between Pernambuco and Catuca, date lacking, *Gardner 1961* (K); July, 1887, *Ridley Lea & Ramage s. n.* (BM, K); AMAZONAS: Roraima, alt. 1200 m., Febr., 1910, *Ule s. n.* (B); bei S. Marcos, Rio Branco, Jan. 1909, *Ule 7823* (B) Boa Vista, Rio Branco super, ad marginem silvae, July, 1913, *Kuhlmann 3651* (B, US); GOYAZ: between Riacho and Catalão, 23 Sept. 1827, *Burchell 5946* (Bx, K); civit. Goyaz, 1894–95, *Glaziou 21718* (B); BAHIA: St. Thoma, int. Jacobina et Villanova, 1845, *Blanchet 3797* (BM); MATTO GROSSO: Serra de Cujaba, date lacking, *Manso & Lhotzky 2* (B); June 11, 1899, *Pilger 670* (B); ad villam Cujabam, date lacking, *Manso & Lhotzky 29* (B, DC); Cujaba, in silvula, loco subhumido, Dec. 5, 1893, *Malme 1196* (B); DATA INCOMPLETE: 1842, *Blanchet 3636* (BM); 1859, *Sello 217* (K, NY); *Riedel, s. n.* (B, BB, G); *Blanchet 1387* (BM); *Sello 998* (B).

BOLIVIA: LA PAZ: Yungas, alt. 6000 ft., 1885, *Rusby 2387* (FM, NY); Polo-Polo, bei Coroico, Nord-Yungas, Oct.–Nov. 1912, *Buchtien 4673* (US); SANTA CRUZ: bosque virgen, Rio Vibora, Prov. Tchilo, alt. 350 m., June 10, 1926, *Steinbach 7577* (S); DATA INCOMPLETE: *Bang 2843* (B, FM, K, MBG, NY, US); *Miers 98* (BM).

M. hirsuta has the distinction of being perhaps the most widespread, frequent, uniform, and also the most complex bibliographically of the species of *Mandevilla*. After a study of a wealth of herbarium material, much of which is cited above, it is hard to understand how the species could successfully be subdivided, since all evident characteristics, such as floral and foliar structure, pubescence, etc., are unusually uniform for a species of such a wide geographical distribution. The complex synonymy can undoubtedly be ascribed largely to the meagre specimens and poor bibliographical aids of the earlier authors and the changing generic concepts of their successors.

Passing reference should be made to *Echites campestris* Vell., provisionally assigned to synonymy under *M. hirsuta*. Velloso's species contains no characteristics, either in the rather inadequate plate or in the equally inadequate description, which distinguish it effectively from *M. hirsuta* except that it is reported as bearing solitary axillary flowers. The plate in the 'Flora Fluminensis,' however, shows that the flowers are immediately subtended by several foliaceous or petalaceous bracts. The outline and indument of the leaves also support such a disposition of the species.

97. Mandevilla sagittarii Woodson, Ann. Mo. Bot. Gard. **19:** 72. 1932.

Suffruticose lianas; stems terete, relatively stout, ferruginous-hispidulous to glabrate; leaves opposite, petiolate, broadly oblong- to obovate-elliptic, apex abruptly subcaudate-acuminate, 4–6 cm. broad, firmly membranaceous, above sparsely strigillose, glandular along the midrib, beneath densely tomentulose; petiole 1.0–1.5 cm. long; racemes lateral, about half as long as the subtending leaves, bearing 5–15 showy, reddish-yellow flowers; pedicels 0.7–0.8 cm. long; bracts ovate, caudate-acuminate, sessile, 1.0–1.5 cm. long, petaloid; calyx-lobes linear-lanceolate, 0.7–0.8 cm. long, slightly petaloid, sparsely and minutely pilosulose, the opposite, solitary squamellae deltoid, indistinctly erose; corolla typically infundibuliform, pilosulose without, the proper-tube indistinctly gibbous, 2.5 cm. long, about 0.2 cm. in diameter at the base, the throat broadly tubular, 3 cm. long, about 0.75 cm. in diameter at the orifice, the lobes obliquely obovate, 1.5 cm. long, spreading; anthers 0.3–0.4 cm. long, auriculate; ovary ovoid, about 0.2 cm. long, glabrous or minutely papillate; stigma 0.15 cm. long, shortly apiculate; nectaries 5, compressed-obovoid, about half as long as the ovary; follicles relatively slender, obscurely moniliform, 12–15 cm. long, hispidulous; seeds 1 cm. long, the brilliant tawny coma about 2 cm. long.

COLOMBIA: CHOCO: between La Oveja and Quibdo, April 1–2, 1931, *Archer 1714* (US, TYPE, MBG, photograph and analytical drawings).

98. Mandevilla Moritziana (Muell.-Arg.) Donn. Sm. Enum. Pl. Guat. **3:** 50. 1893, as to name-bringing synonym, not as to specimens cited.

Amblyanthera Moritziana Muell.-Arg. Linnaea **30:** 421. 1860; Miers, Apoc. So. Am. 189. 1878.

Suffruticose lianas; stems relatively slender, rather sparsely ferruginous-hirtellous to glabrate; leaves opposite, petiolate, ovate to ovate-lanceolate, apex acute to acuminate, base obscurely auriculate, 8–14 cm. long, 3–8 cm. broad, membranaceous, above sparsely and minutely strigillose to glabrate, glandular along the midrib, beneath sparsely hirtellous to glabrate; petioles 1.0–1.5 cm. long; racemes lateral, usually somewhat shorter than the

subtending leaves, bearing 15–30 pale yellowish flowers; pedicels 0.5–1.0 cm. long; bracts oblanceolate or spatulate, clawed, 1–2 cm. long, petaloid; calyx-lobes ovate-lanceolate, acuminate, 0.2–0.3 cm. long, scarious, the opposite, solitary squamellae trigonal-ligular, entire or slightly erose; corolla typically infundibuliform, glabrous without, the proper-tube distinctly gibbous, 1.5–2.0 cm. long, about 0.2 cm. in diameter at the base, the throat conical-campanulate, 1.5 cm. long, about 1 cm. in diameter at the orifice, the lobes obliquely obovate, 1 cm. long, spreading; anthers 0.3 cm. long, obscurely auriculate; ovary ovoid-oblongoid, about 0.15 cm. long, glabrous; stigma 0.15 cm. long, shortly apiculate; nectaries 5, compressed-ovoid, about half as long as the ovary; follicles relatively slender, conspicuously articulated, 20–25 cm. long, glabrous or very sparsely and minutely hirtellous; seeds about 1.25 cm. long, the brilliant tawny coma about 2.5 cm. long.

VENEZUELA: MERIDA: a few miles s. e. of Colonia Tovar, alt. 4000 ft., Febr. 27, 1857, *Fendler 2382* (G); ARAGUA: El Portachuelo, between Maracay and Acumare de la Costa, Jan. 29, 1922, *Pittier 10127* (US); DISTRITO FEDERAL: Caracas, date and collector unknown (S); DATA INCOMPLETE: *Moritz 31* (BB, TYPE, MBG, photograph and analytical drawings).

The specimens assigned to this species by Capt. Smith are all plants of Guatemala properly referable to *M. villosa* (Miers) Woodson. Nevertheless, the authorship of the combination must remain as cited in the preceding paragraphs, as such a change in nomenclature is purely mechanical, and incorrect assignment of specimens at the time of the change, although embarrassing, should not affect its validity.

99. **Mandevilla polyantha** K. Sch. ex Woodson, Ann. Mo. Bot. Gard. **19**: 73. 1932.

Mandevilla polyantha K. Sch. in Engl. Bot. Jahrb. **40**: 403. 1908, nom. nud.

Suffruticose lianas; stems terete, relatively slender, pilose or pilosulose to glabrate; leaves opposite, petiolate, broadly elliptic to obovate-elliptic, apex acuminate, base rather narrowly and obscurely cordate, 7–12 cm. long, 3–6 cm. broad, membranaceous, above sparsely pilosulose and glandular along the midrib, beneath laxly puberulent, particularly along the veins and midrib;

petioles 1.0–1.5 cm. long; racemes lateral, about twice as long as the subtending leaves, bearing 20–35 greenish-white or yellowish flowers; pedicels secund, 1 cm. long, conspicuously accrescent after maturity; bracts minutely linear, scarious; calyx-lobes broadly trigonal, acute, 0.1 cm. long, scarious, densely puberulent-papillate, the opposite solitary squamellae deltoid, denticulate; corolla typically infundibuliform, glabrous without, the proper-tube conspicuously gibbous, more or less ventricose, 1.0–1.25 cm. long, about 0.15 cm. in diameter at the base, the throat conical, about 1 cm. long, 0.5 cm. in diameter at the orifice, the lobes obliquely obovate-reniform, 0.25 cm. long, widely spreading; anthers 0.3 cm. long, rather obscurely auriculate; ovary ovoid-oblongoid, about 0.15 cm. long, glabrous; stigma 0.1 cm. long, shortly apiculate; nectaries 5, compressed-ovoid, scarcely as long as the ovary; mature follicles unknown.

Peru: loreto: Yurimaguas, lower Rio Huallaga, alt. 135 m., woods, Aug. 22–Sept. 9, 1929, *Killip & Smith 27579* (MBG, US); Yurimaguas, Aug., 1902, *Ule 6271* (B, type, MBG, photograph and analytical drawings).

100. Mandevilla caurensis Mgf. Notizblatt 9: 87. 1924.

Erect, ascending, or clambering, suffruticose undershrubs; stems distinctly alate, relatively stout, glabrous; leaves opposite, petiolate, oblong-elliptic, apex shortly acuminate, base cuneate-rounded, 10–12 cm. long, 4.0–4.5 cm. broad, firmly chartaceous, glabrous, glandular along the midrib above; petioles 1.0–1.5 cm. long; racemes simple, terminal; pedicels 0.1–0.15 cm. long; bracts scarious, 0.1 cm. long; calyx-lobes ovate-trigonal, acute, 0.1 cm. long, scarious, glabrous, the solitary opposite squamellae lacerate; corolla infundibuliform, glabrous without, the proper-tube somewhat gibbous or arcuate, 2.5 cm. long, about 0.3–0.4 cm. in diameter at the base, the throat somewhat narrowly conical, 3 cm. long, about 0.5 cm. in diameter, the lobes obliquely obovate, 2.5 cm. long, widely spreading; anthers truncate, 0.7 cm. long; stigma very shortly apiculate; nectaries 5, compressed-obovoid, about half as long as the ovary; ovary ovoid, about 0.2 cm. long, glabrous; follicles unknown.

Venezuela: bolivar: Cuchivero, Febr. 22, 1902, *Selwyn 801* (B); Caura-Gebiet am oberen Orinoco, Bergwälder bei Santa Lucia, Dec. 7, 1901, *Passarge 86* (B, type, MBG, photograph and analytical drawings).

101. Mandevilla Vanheurckii (Muell.-Arg.) Mgf. Notizblatt 9: 87. *fig. 2L.* 1924.

Heterothrix Vanheurckii Muell.-Arg. in Van Heurck, Bot. Obs. 164. 1871.

Eriadenia obovata Miers, Apoc. So. Am. 117. 1878.

Heterothrix Van Heurckii Müll. ex Miers, loc. cit. 264. 1878, sphalm.

Mandevilla glabra N. E. Br. Trans. Linn. Soc. Bot. II. 6: 47. 1906.

Erect, ascending, or clambering, suffruticose undershrubs; stems irregularly alate, relatively stout, glabrous; leaves opposite, petiolate, elliptic to obovate-lanceolate, apex acute to obtuse, cuspidate or somewhat subcaudate, occasionally rounded, base acute to attenuate, 5–8 cm. long, 1.5–3.0 cm. broad, coriaceous, glabrous, glandular along the midrib above; racemes lateral or subterminal, commonly somewhat longer than the subtending leaves, bearing 3–15 yellowish flowers; pedicels 0.2–0.3 cm. long; bracts ovate, about 0.1 cm. long, scarious; calyx-lobes ovate, acute, 0.1–0.2 cm. long, scarious, puberulent-papillate, the opposite solitary squamellae deeply lacerate; corolla infundibuliform, glabrous without, the proper-tube somewhat gibbous, 2–3 cm. long, about 0.15 cm. in diameter at the base, throat shortly conical, 1.5–2.0 cm. long, about 1 cm. in diameter at the orifice, the lobes obliquely obovate, 1 cm. long, widely spreading; anthers obscurely auriculate, 0.6–0.7 cm. long; ovary ovoid, about 0.2 cm. long, minutely puberulent-papillate; stigma 0.2 cm. long, shortly apiculate; nectaries 5, compressed-obovoid, about one-third as long as the ovary; follicles relatively slender, slightly articulated, 10–15 cm. long, glabrous; seeds about 0.6 cm. long, the tawny coma about 1.5 cm. long.

PERU: LORETO: prope Tarapoto, 1855–56, *Spruce 4303* (Camb., K, V, MBG, photograph and analytical drawings); Berge östlich von Moyobamba, in einer Übergangsformation zwischen Savannen- und Hartlaubgestrauch, alt. 1300–1400 m., Sept. 18, 1904, *Weberbauer 4740* (B, MBG, photograph and analytical drawings).

102. Mandevilla Ulei Mgf. Notizblatt 9: 86. *fig. 2M.* 1924.

Erect or ascending, suffruticose undershrubs; stems inconspicuously alate, relatively stout, minutely puberulent when young, eventually becoming glabrate; leaves opposite, petiolate, obovate-

oblong, apex abruptly and shortly acuminate, base shortly angustate, 10–12 cm. long, 5–6 cm. broad, coriaceous, glabrous, glandular along the midrib above; petioles 1.0–1.5 cm. long; racemes somewhat shorter than the subtending leaves, simple, bearing 10–15 deep yellowish flowers; pedicels about 0.1 cm. long; bracts minutely ovate-trigonal, scarious; calyx-lobes ovate-trigonal, acute, about 0.25 cm. long, puberulent-papillate without, the opposite solitary squamellae somewhat erose; corolla infundibuliform, minutely puberulent-papillate without, the proper-tube somewhat gibbous or arcuate, about 3 cm. long, about 0.3 cm. in diameter at the base, the throat about 3 cm. long, about 3 cm. in diameter at the orifice, the lobes obliquely obovate, shortly acuminate, about 2 cm. long, widely spreading; anthers very obscurely auriculate, 0.7 cm. long; ovary ovoid-oblongoid, about 0.2 cm. long, minutely puberulent; stigma 0.3 cm. long, long-apiculate; nectaries 5, compressed-oblongoid, concrescent at the base, about ⅓ as long as the ovary; mature follicles unknown.

Brazil: amazonas: Manãos, am Waldrand bei Flores, July 31, 1900, *Ule 5176* (B, type).

103. **Mandevilla subcarnosa** (Benth.) Woodson, in Gleason, Bull. Torrey Bot. Club **58**: 453. 1931.

Echites subcarnosa Benth. in Hook. Jour. Bot. **3**: 247. 1841.

Mesechites subcarnosa (Benth.) Miers, Apoc. So. Am. 231. 1878.

Mandevilla subcarnosa Benth. & Hook. ex Miers, loc. cit. 1878, sphalm in synon.

Mandevilla Dielsiana Mgf. Notizblatt **9**: 86. 1924.

Erect, ascending or clambering, suffruticose undershrubs; stems irregularly compressed or alate, relatively stout, glabrous; leaves opposite, petiolate, broadly oblong-elliptic, apex obtuse to rounded, base rounded or very obscurely cordate, 4.5–8.0 cm. long, 2.0 cm. broad, coriaceous, glabrous, glandular along the midrib above; petioles 0.4–0.5 cm. long; racemes terminal to subterminal, commonly somewhat exceeding the length of the subtending leaves, bearing 10–30 yellowish flowers; pedicels 0.4–0.6 cm. long; bracts minutely ovate, scarious; calyx-lobes

ovate, acute, about 0.1 cm. long, scarious, minutely papillate, the opposite solitary squamellae deeply lacerate; corolla infundibuliform, glabrous without, the proper-tube inconspicuously gibbous, 2.0–2.5 cm. long, about 0.15 cm. in diameter at the base, the throat campanulate, 1.0–1.5 cm. long, about 1.5 cm. in diameter at the orifice, the lobes obliquely obovate, 0.5 cm. long, spreading; anthers obscurely auriculate, 0.7 cm. long; ovary ovoid, about 0.15 cm. long, puberulent-papillate; stigma 0.3 cm. long, shortly apiculate; nectaries 5, compressed-obovoid, about ⅓ as long as the ovary; follicles relatively stout, slightly articulated, 8–12 cm. long, glabrous; seeds about 0.6 cm. long, the brilliant tawny coma about 1.5 cm. long.

VENEZUELA: AMAZONAS: in der Restinga bei Schaweila Mota, Rio Cuquenan, Dec., 1909, *Ule 8737* (B, MBG, photograph and analytical drawings); rocky top of Esmeralda Ridge, alt. about 325 ft., Oct. 6, 1928, *Tate 188* (MBG, NY).

BRITISH GUIANA: Roraima, date lacking, *Schomburgk 183* (K, TYPE, MBG, photograph and analytical drawings).

104. **Mandevilla lancifolia** Woodson, Ann. Mo. Bot. Gard. 19: 74. 1932.

Erect or ascending, suffruticose undershrubs; stems compressed or more or less alate, relatively slender, densely puberulent-papillate when young, eventually glabrate; leaves opposite, very shortly petiolate, linear-lanceolate, 3–6 cm. long, 0.5–0.7 cm. broad, firmly membranaceous, glabrous, inconspicuously glandular along the midrib above; petioles 0.1–0.3 cm. long; racemes lateral to subterminal, about twice as long as the subtending leaves, bearing 1–7 yellowish flowers; pedicels 0.15 cm. long; bracts minutely ovate, scarious; calyx-lobes ovate, acute, 0.15–0.2 cm. long, scarious, glabrous or minutely papillate, the opposite, solitary squamellae profoundly lacerate; corolla infundibuliform, glabrous without, the proper-tube very inconspicuously gibbous, 1 cm. long, about 0.1 cm. in diameter at the base; the throat tubular-conical, 1.5–2.0 cm. long, about 0.5 cm. in diameter at the orifice, the lobes obliquely obovate, 1.5–2.0 cm. long, spreading; anthers obscurely auriculate, 0.6 cm. long; ovary narrowly oblongoid, about 0.2 cm. long, glabrous; stigma 0.2 cm. long, very shortly apiculate; nectaries 5, compressed-obovoid, about ¼ as long as the ovary; follicles slender, obscurely

articulated, 7–10 cm. long, glabrous; seeds 0.5 cm. long, the brilliant coma 1.5 cm. long.

Venezuela: amazonas: prope Maypures, ad flumen Orinoco, June, 1854, *Spruce 3610* (K, V, MBG, photograph and analytical drawings); Puerto Ayacucho, alt. 100 m., May, 1931, *Holt & Blake 819* (MBG, type, US).

105. Mandevilla anceps Woodson, Ann. Mo. Bot. Gard. **19**: 75. 1932.

Erect or ascending, suffruticose undershrubs; stems conspicuously alate, relatively stout, minutely puberulent when young, eventually glabrate; leaves opposite, shortly petiolate, broadly elliptic-oblong, apex acute to abruptly acuminate, base obsoletely cordate, 5–8 cm. long, 2–3 cm. broad, subcoriaceous, above minutely puberulent-papillate, inconspicuously glandular along the midrib, beneath densely puberulent; petioles 0.5 cm. long; racemes lateral or subterminal, shorter than the subtending leaves, bearing 3–5 yellowish flowers; pedicels 0.2–0.3 cm. long; bracts minutely ovate, scarious; calyx-lobes ovate-lanceolate, acuminate, 0.15 cm. long, scarious, minutely puberulent-papillate, the opposite, solitary squamellae deltoid, lacerate; corolla infundibuliform, minutely puberulent-papillate without, the proper-tube very inconspicuously gibbous, 2.5–3.0 cm. long, about 0.1 cm. in diameter at the base, the throat conical, 2 cm. long, about 1 cm. in diameter at the orifice, the lobes obliquely obovate-reniform, 1.5 cm. long, widely spreading; anthers auriculate, 0.5 cm. long; ovary ovoid-oblongoid, about 0.1 cm. long, densely puberulent-papillate; stigma 0.15 cm. long, obscurely apiculate; nectaries 5, compressed-oblongoid, scarcely as long as the ovary; follicles slender, somewhat articulated, 9 cm. long, minutely puberulent; seeds 0.5 cm. long, the tawny coma 1.5 cm. long.

Brazil: amazonas: "in montic. Tarurumari fluvii Pacimoni," Febr. 1854, *Spruce 3395* (K, type, MBG, photograph and analytical drawings).

106. Mandevilla Benthamii (A. DC.) K. Sch. in Engl. & Prantl, Nat. Pflanzenfam. 4^2: 171. 1895.

Echites angustifolia Benth. in Hook. Jour. Bot. **3**: 247. 1841, not Poir.

Echites Benthamii A. DC. in DC. Prodr. **8**: 467. 1844.

Amblyanthera Benthamii (A. DC.) Muell.-Arg. Linnaea **30**: 451. 1860.

Mesechites angustata Miers, Apoc. So. Am. 231. 1878.

Erect or ascending, suffrutescent undershrubs; stems irregularly compressed or alate, relatively stout, minutely puberulent when young, eventually glabrate; leaves verticillate, commonly ternate or quaternate, crowded, sessile or subsessile, linear-lanceolate, 1.5–4.0 cm. long, 0.2–0.4 cm. broad, coriaceous, glabrous, above inconspicuously glandular along the midrib; racemes terminal or subterminal, rarely lateral, conspicuously longer than the subtending leaves, bearing 5–30 congested, yellowish flowers; pedicels 0.1–0.2 cm. long; bracts minutely ovate, scarious; calyx-lobes ovate, acute, about 0.1 cm. long, scarious, glabrous, the opposite, solitary squamellae deeply lacerate; corolla infundibuliform, glabrous without, the proper-tube gibbous, 1.0–1.25 cm. long, about 0.1 cm. long, the throat conical, 1.0–1.5 cm. long, about 0.75 cm. in diameter at the orifice, the lobes obliquely obovate, 1 cm. long, widely spreading; anthers obscurely auriculate, 0.5–0.6 cm. long; ovary ovoid, about 0.2 cm. long, glabrous; stigma about 1.5 cm. long, shortly apiculate; nectaries 5, compressed-obovoid, about half as long as the ovary; follicles relatively slender, continuous or slightly articulated, 8–12 cm. long, glabrous; seeds 0.5 cm. long, the brilliant tawny coma 2 cm. long.

British Guiana: Kaieteur Savannah, Potaro River, Sept.–Oct., 1881, *Jenman 1224* (K, MBG, photograph and analytical drawings); Cako Creek, June, 1864, *Appun 1914* (K); among underwood in the sandstone region of Roraima, 1840, *Schomburgk 1953* (K, type); Kaieteur Savannah, about the commonest of the low plants on this savannah, Febr. 24, 1879, *im Thurn* (K); Kaieteur Plateau, Potaro River, alt. 1300 ft., May, 1926, *Loz 543* (K).

107. **Mandevilla javitensis** (HBK.) K. Sch. in Engl. & Prantl, Nat. Pflanzenfam. 4²: 171. 1895.

Echites javitensis HBK. Nov. Gen. **3**: 220. 1819; A. DC. in DC. Prodr. **8**: 461. 1844.

Exothostemon Javitense (HBK.) G. Don, Hist. Dichlam. Pl. **4**: 82. 1838; Miers, Apoc. So. Am. 239. 1878.

Erect or ascending undershrubs; stems compressed, relatively stout, glabrous; leaves opposite, oblong-elliptic, apex abruptly and shortly acuminate, base obtuse or rounded, 10–12 cm. long, 4–5 cm. broad, coriaceous, glabrous, or very minutely papillate beneath, glandular along the midrib above; petioles 1.0–1.5 cm.

long; racemes somewhat longer than the subtending leaves, terminal, simple; pedicels about 0.1–0.2 cm. long; bracts 2.5–4.0 cm. long, oblong-obovate, obtuse to rounded, flat, somewhat petalaceous, deciduous; calyx-lobes ovate-trigonal, broadly acute to obtuse, 0.2 cm. long, glabrous or slightly ciliolate, the opposite, solitary squamellae somewhat erose or lacerate; corolla infundibuliform, glabrous without, the proper-tube somewhat gibbous or arcuate, 2.5–3.0 cm. long, about 0.3 cm. in diameter at the base, the throat broadly conical, 2.0–2.5 cm. long, about 2 cm. in diameter at the orifice, the lobes obliquely obovate, shortly acuminate, 2 cm. long, widely spreading; anthers obscurely auriculate, 0.7 cm. long; ovary ovoid, about 0.2 cm. long, glabrous; stigma 0.3 cm. long, shortly apiculate; nectaries compressed-obovoid, about half as long as the ovary; mature follicles unknown.

Venezuela: amazonas: ad ripam obumbratum fluminis Temi, prope Javita, date lacking, *Humboldt & Bonpland s. n.* (type).

Brazil: amazonas: Cachoeira, sandy ground recently cleared, 1898, *Gwynne-Vaughn 31* (K, MBG, photograph).

108. **Mandevilla Spruceana** (Muell.-Arg.) K. Sch. in Engl. & Prantl, Nat. Pflanzenfam. 4²: 171. 1895.

Amblyanthera Spruceana Muell.-Arg. in Mart. Fl. Bras. 6¹: 143. 1860; Miers, Apoc. So. Am. 190. 1878.

Erect or ascending, suffruticose undershrubs; stems compressed, relatively stout, minutely puberulent when young, eventually becoming glabrate; leaves opposite, petiolate, oblong-elliptic, apex abruptly and shortly acuminate, base obtuse, 7–9 cm. long, 2.5–4.0 cm. broad, coriaceous, glabrous, or minutely puberulent-papillate beneath, glandular along the midrib above; petioles 1.0–1.5 cm. long; racemes somewhat shorter than the subtending leaves, terminal, simple, bearing 10–25 showy, cream-colored flowers; pedicels about 0.1 cm. long; bracts oblong-lanceolate, subcaudate-acuminate, 0.2–0.3 cm. long, petalaceous, more or less navicular or carinate; calyx-lobes ovate-trigonal, broadly acute to obtuse, 0.4 cm. long, glabrous, scarious, the opposite, solitary squamellae deeply lacerate; corolla infundibuliform, glabrous without, or minutely papillate when immature, the proper-tube slightly gibbous or arcuate, 2.0–2.5 cm. long, about

0.25 cm. in diameter at the base, the throat conical-campanulate, 1.5–2.0 cm. long, about 1.5 cm. in diameter at the orifice, the lobes obliquely obovate, shortly acuminate, 2.0–2.5 cm. long, widely spreading; anthers obscurely auriculate, 0.7 cm. long; ovary ovoid, about 0.2 cm. long, glabrous or minutely papillate; stigma 0.2 cm. long, shortly apiculate; nectaries 5, compressed-oblongoid, more or less concrescent, about half as long as the ovary; follicles unknown.

BRAZIL: AMAZONAS: San Carlos, in sylv. humilior. April, 1854, *Spruce s. n.* (K, MBG, photograph); prope Panure ad Rio Uahupes, Oct. 1852–Jan., 1853, *Spruce 2863* (Camb., V, ISOTYPE).

EXCLUDED SPECIES

Mandevilla potosina Brandg. Univ. Calif. Publ. Bot. **4**: 276. 1912 = **Fernaldia pandurata** (A. DC.) Woodson, Ann. Mo. Bot. Gard. **19**: 48. 1932.

Mandevilla velutina K. Sch. in Engl. & Prantl, Nat. Pflanzenfam. **4**^{2}: 171. 1895 = **Fernaldia pandurata** (A. DC.) Woodson, loc. cit. 1932.

IV. MACROSIPHONIA Muell.-Arg.

Macrosiphonia Muell.-Arg. in Mart. Fl. Bras. **6**^{1}: 137. 1860; Benth. & Hook. Gen. Pl. **2**: 726. 1876; Miers, Apoc. So. Am. 129. 1878; K. Sch. in Engl. & Prantl, Nat. Pflanzenfam. **4**^{2}: 166. 1895.

Echites of early authors, in part, not P. Br.

Lactescent, suffrutescent herbs or undershrubs. Stems erect or ascending, frequently more or less decumbent, terete; branches opposite below, becoming alternate above. Leaves opposite or verticillate, shortly petiolate to sessile, the blade firmly membranaceous to coriaceous, entire or more or less undulate-crisped, penninerved, glandular at the base of the midrib above. Inflorescence terminal, subterminal, or lateral, racemose, reduced to 1–2 flowers in certain species, always few-flowered, the pedicels subtended by one to several bracts. Flowers white or cream-colored, frequently suffused with pink, drying brownish-orange, nyctanthous or vespertine. Calyx 5-parted, the lobes subequal, imbricated, cleft nearly to the receptacle, bearing within many uniformly distributed, glandular squamellae. Corolla infundi-

buliform, the proper-tube narrowly cylindrical, straight, abruptly dilated at the insertion of the stamens into the conical or campanulate throat, the limb 5-parted, actinomorphic, dextrorsely convolute. Stamens 5, included; anthers connivent and directly agglutinated to the stigma, consisting of 2 parallel, uniformly fertile sporangia borne ventrally near the apex of an enlarged, sagittate, obtusely 2-auriculate, peltate connective; pollen granular; filament very short, subcylindrical, pilose. Carpels 2, united at the apex by an elongate, stylar shaft surmounted by the pentagonal-subglochidiate stigma; ovules many, several-seriate, anatropous, borne upon an axile, binate placenta. Nectaries 5, separate or somewhat concrescent at the base. Follicles apocarpous, terete, continuous or articulated, dehiscing along the ventral suture, containing many dry, subscaphiform, truncate, apically comose seeds.

Type species: *Macrosiphonia Velame* (St. Hil.) Muell.-Arg. in Mart. Fl. Bras. 6[1]: 138. 1860.

KEY TO THE SUBGENERA

A. Calyx not immediately subtended by bracts; species of North America . . . . .Subgen. I. Telosiphonia

AA. Calyx immediately subtended by bracts; species of South America. . . . . .Subgen. II. Eumacrosiphonia

The congenericity of the two subgenera of *Macrosiphonia* may well be questioned. Their greatly separated ranges of distribution, coinciding roughly with the extremes of the extensive distribution of the large genus *Mandevilla,* would appear to allow the interpretation of parallel or independent origin as the result of somewhat similar environment as more logical than the supposition of a previously more extended range. As has already been pointed out, however, the existing distinctions between *Macrosiphonia* and *Mandevilla* are extremely tenuous. Further segregation of the former, therefore, appears inadmissible at the present time. On the other hand, the species included within *Macrosiphonia* form such a distinctive element that it does not appear desirable to unite them with *Mandevilla.*

Subgen. I. Telosiphonia Woodson, n. subgen.

Flowers mostly solitary, occasionally 2, rarely 3–4. Peduncle

manifest or obsolete; pedicels always manifest. Calyx foliaceous or somewhat petalaceous, not immediately subtended by bracts. Suffrutescent herbs (fruticose in *M. Hesperia*) of northern and central Mexico and the extreme southwestern United States. *Spp. 1-5.*

KEY TO THE SPECIES

a. Plants fruticose; stems about 1 m. tall, ligneous throughout....*1. M. Hesperia*
aa. Plants suffrutescent; stems 0.1–0.3 m. tall, predominantly herbaceous.
  b. Corolla-tube barely as long as the throat, or shorter; inflorescence 1–3- (rarely 4-) flowered.
    c. Leaves ovate to ovate-elliptic, 1.5–3 cm. long, minutely puberulent to glabrate; inflorescence without an evident peduncle; plants of southern Arizona, extreme southwestern New Mexico, and northern Sonora.......................................*2. M. Brachysiphon*
    cc. Leaves narrowly oblong to linear, 2–9 cm. long, hirtellous to glabrate above, tomentulose beneath; inflorescence with an evident peduncle; plants of northeastern and central Mexico...........*3. M. hypoleuca*
  bb. Corolla-tube much longer than the throat; flowers solitary (rarely 2–3 in *4*).
    c. Calyx-lobes somewhat petalaceous......................*4. M. lanuginosa*
    cc. Calyx-lobes foliaceous.............................*5. M. Macrosiphon*

1. **Macrosiphonia Hesperia** I. M. Johnston, Proc. Cal. Acad. Sci. IV. **12**: 1125. 1924.

Erect or rather diffuse shrubs 0.7–1.0 m. tall; stems ligneous throughout, densely and minutely puberulent when young, becoming glabrate; leaves opposite, shortly petiolate, ovate-orbicular, apex abruptly rounded, mucronulate, frequently more or less retuse, base broadly and very obscurely cordate, 2–3 cm. long, 1.8–2.5 cm. broad, subcoriaceous, hirtellous above, densely tomentulose beneath; petioles 0.2–0.3 cm. long; inflorescence terminal, somewhat shorter than the subtending leaves, bearing 1–2(–3) white, vespertine flowers; pedicels 0.4–0.7 cm. long, somewhat accrescent in fruit; bracts minutely linear; calyx-lobes oblong to oblong-spatulate, 0.8 cm. long, densely and minutely hirtellous; corolla infundibuliform, glabrous without, the proper-tube 4–5 cm. long, about 0.1 cm. in diameter at the base, the throat narrowly conical or subtubular, 0.8 cm. long, about 0.3–0.4 cm. in diameter at the orifice, the lobes obliquely obovate, 1.25 cm. long, widely spreading; follicles more or less torulose, 10–12 cm. long, essentially glabrous; seeds 0.5–0.75 cm. long, the tawny coma of approximately equal length.

MEXICO: BAJA CALIFORNIA: Puerto Bellandra, Carmen Island, May 21, 1921, *Johnston 3807* (CA, TYPE, US, MBG, photograph); Espiritu Santo Island, the isthmus, rocky ground in the upper part of gulches, May 31, 1921, *Johnston 3984* (CA); Agua Verde Bay, frequent on ledges and to some extent in gravel in a large canyon back from bay, May 26, 1921, *Johnston 3888* (CA); head of Concepcion Bay, April 6, 1911, *Rose 16700* (NY, US); Carmen Island, Nov. 1–7, 1890, *E. Palmer 841* (G, US).

2. **Macrosiphonia Brachysiphon** (Torr.) A. Gray, Syn. Fl. 2^1: 83. 1878; Hemsl. Biol. Centr.-Am. Bot. **2**: 315. 1882; K. Sch. in Engl. & Prantl, Nat. Pflanzenfam. 4^2: 168. 1895.

Echites Brachysiphon Torr. Bot. Mex. Bound. Surv. 158. 1859.

Erect or diffuse, suffrutescent herbs 1–3 dm. tall; stems densely and minutely puberulent when young, becoming glabrate; leaves opposite, shortly petiolate, ovate to ovate-elliptic, apex acute, base abruptly rounded to obtuse, 1.5–3.0 cm. long, 0.7–1.5 cm. broad, membranaceous, either surface minutely puberulent to glabrate; petioles 0.1–0.2 cm. long; inflorescence terminal, bearing 1–3 white, vespertine flowers, the peduncle scarcely manifest, or obsolete; pedicels 0.5–1.25 cm. long, somewhat accrescent in fruit; bracts minutely linear to linear-lanceolate; calyx-lobes narrowly oblong, acute to acuminate, 0.5–0.7 cm. long, 0.2–0.3 cm. broad, somewhat petalaceous, minutely puberulent to glabrate; corolla infundibuliform, densely and minutely puberulent-papillate without, the proper-tube 1.0–1.5 cm. long, about 0.1 cm. in diameter at the base, the throat narrowly conical or subtubular-conical, 1.0–1.25 cm. long, about 0.4 cm. in diameter at the orifice, the lobes obliquely obovate, acuminate, 0.7–1.3 cm. long, widely spreading; follicles slender, continuous or slightly articulated, 8–10 cm. long, minutely puberulent-papillate; seeds about 0.5 cm. long, the tawny coma about 1 cm. long.

UNITED STATES: ARIZONA: 8 mi. south of Vail, Aug. 31, 1903, *Jones s. n.* (MBG, S, US); Santa Cruz River, near Nogales, Aug. 15, 1900, *Trelease 353* (MBG); Montezuma Canyon, Huachuca Mts., July 10, 1909, *Wilcox s. n.* (MBG, NY, US); Nogales, May 24, 1892, *Brandegee s. n.* (UC); Connolly's Ranch, Huachuca Mts., Aug., 1882, *Lemmon s. n.* (UC, US); ravines in mountains on the Wallen road, near Davidson's Springs, Aug. 4, 1867, *E. Palmer 205* (MBG); Sonrita Valley, alt. 5500 ft., Aug., 1874, *Rothrock 646* (FM, US); data incomplete, *Wright 1665* (G, MBG, NY, US); NEW MEXICO: Camp Bowie, alt. 5500 ft., Aug., 1874, *Rothrock 497* (FM, G, US, S).

MEXICO: SONORA: between Nogales and Cocospora Ranch, Aug. 15–17, 1904, *Griffiths 6781* (MBG); Las Cuervas, alt. 4900 ft., Oct. 15, 1890, *Hartmann 157* (G);

Hermosillo, 1888, *Crawford s. n.* (G); about 15 mi. below U. S. boundary, 1912, *Ricketts s. n.* (US); Niggerhead Mts., near monument no. 82, Aug. 15, 1893, *Mearns 1884* (US); San Jose Mts., alt. 6000 ft., Aug. 11, 1893, *Mearns 1755* (US); San Bernardino, Aug., 1882, *Thurber 764* (NY).

3. **Macrosiphonia hypoleuca** (Benth.) Muell.-Arg. Linnaea 30: 452. 1860; Hemsl. Biol. Centr.-Am. Bot. 2: 315. 1882; K. Sch. in Engl. & Prantl, Nat. Pflanzenfam. 4^2: 168. 1895.

Echites hypoleuca Benth. Pl. Hartw. 23. 1839; A. DC. in DC. Prodr. 8: 472. 1844.

Echites suaveolens Mart. & Gal. Bull. Acad. Roy. Brux. 11^1: 356. 1844, not A. DC.

Macrosiphonia Wrightii A. Gray, Syn. Fl. 2^1: 83. 1878.

Rhodocalyx suaveolens (Mart. & Gal.) Miers, Apoc. So. Am. 139. 1878.

Rhodocalyx hypoleucus (Benth.) Miers, loc. cit. 140. 1878.

Erect or diffuse, suffrutescent herbs 1–3 dm. tall; stems densely puberulent when young, eventually becoming glabrate; leaves opposite, shortly petiolate, narrowly oblong to linear, apex acute, infrequently acuminate or narrowly obtuse, base abruptly rounded, obtuse, or truncate, 2–9 cm. long, 0.4–2.25 cm. broad, firmly membranaceous, above dark green, hirtellous to glabrate, beneath much paler, finely tomentulose; inflorescence terminal, bearing 1–3(–4) white, vespertine flowers, the peduncle manifest, somewhat shorter than the subtending leaves; pedicels 0.5–1.0 cm. long, somewhat accrescent in fruit; bracts minutely linear; calyx-lobes narrowly oblong-lanceolate, acuminate, 0.5–1.0 cm. long, somewhat petalaceous, minutely puberulent-tomentulose; corolla infundibuliform, finely floccose-tomentulose without, the proper-tube 1.0–2.5 cm. long, about 1.25 cm. in diameter at the base, the throat narrowly conical or subtubular, 1.5–2.5 cm. long, about 0.5–0.75 cm. in diameter at the orifice, the lobes obliquely obovate, 1.5–2.5 cm. long, widely spreading; follicles relatively stout, continuous or slightly articulated, 9–13 cm. long, finely puberulent-papillate; seeds 0.6–0.75 cm. long, the tawny coma about 1 cm. long.

MEXICO: SAN LUIS POTOSI: in montibus, Aug., 1879, *Schaffner 489* (CA, FM, NY, UC, US); near San Luis Potosi, Aug. 18–20, 1902, *E. Palmer 28* (CA, FM, G, MBG, NY, UC, US); data incomplete, 1878, *Parry & Palmer 574* (FM, G, MBG, US); DURANGO: Sierra Madre Mts., Aug. 13, 1897, *Rose 3474* (US); Papasquiaro, July 7,

1898, *Nelson 4659* (G, US); Otinapa, July 25–Aug. 5, 1906, *E. Palmer 447* (G, US); Tepehuanes, June 4–25, 1906, *E. Palmer 296* (G, US); CHIHUAHUA: San Andres, Aug. 22, 1900, *Trelease 351* (MBG); hills near Chihuahua, Sept.–Oct., 1886, *Pringle 1108* (MBG, NY, UC); rocky hills near Chihuahua, Aug.–Oct., 1885, *Pringle 320* (FM, G, MBG, NY, US); SINALOA: Cerro Colorado, vicinity of Culiacan, Nov. 1, 1904, *Brandegee s. n.* (G, UC, US); Ixtagua, 1922, *Ortega 4712* (US); Cordon de las Trompetas, Ixtagua, San Ignacio, alt. 660 m., Aug. 17, 1918, *Montes & Salazar 486* (US); Cerro Colin, Oct., 1919, *Trejo 1084* (US); JALISCO: hills near Guadalajara, alt. 5000 ft.; July 10, 1902, *Pringle 11014* (FM, G, MBG, NY, US); Guadalajara, Aug., 1901, *Rose & Hay 6292* (G, NY, US); same locality, June 23, 1893, *Pringle 4393* (FM, G, MBG, NY, UC, US, V); near Tequila, July 5–6, 1899, *Rose & Hough 4752* (US); TEPIC: between Pedro Paulo and San Blascito, Aug. 4, 1897, *Rose 1983* (NY, US); plains near city of Tepic, alt. 3000 ft., July 22, 1905, *Goldsmith 126* (G); GUANAJUATO: 1889, *Duges 242* (US); MICHOACAN: data lacking, *Galeotti 1593* (V); STATE UNCERTAIN: date lacking, *Hartweg 193* (K, TYPE, V, MBG, photograph).

4. **Macrosiphonia lanuginosa** (Mart. & Gal.) Hemsl. Biol. Centr.-Am. Bot. **2**: 316. 1882.

Echites lanuginosa Mart. & Gal. Bull. Acad. Roy. Brux. 11¹: 357. 1844.

Rhodocalyx lanuginosus (Mart. & Gal.) Miers, Apoc. So. Am. 139. 1878.

Erect or somewhat diffuse, suffrutescent herbs 1–3 dm. tall; stems densely tomentulose, rarely glabrate; leaves opposite, subsessile, broadly oblong to ovate-elliptic, apex acute to obtuse, base broadly obtuse, rounded, or truncate, 1.5–4.0 cm. long, 0.5–2.0 cm. broad, firmly membranaceous, above dark green, finely hirtellous, beneath much paler, densely tomentulose; inflorescence terminal, bearing 1–3 white, vespertine flowers, the peduncle obsolete or scarcely evident; pedicels 0.5–1.0 cm. long, somewhat accrescent in fruit; bracts minutely linear; calyx-lobes oblong-lanceolate, acuminate, 0.5–0.75 cm. long, somewhat petalaceous; corolla infundibuliform, densely puberulent-papillate without, the proper-tube 3–6 cm. long, about 0.15 cm. in diameter at the base, the throat narrowly conical or subtubular, 1–2 cm. long, about 0.5–0.75 cm. in diameter at the orifice, the lobes obliquely obovate, 1.5–2.0 cm. long, widely spreading; follicles relatively stout, more or less articulated, 10–15 cm. long, irregularly puberulent-papillate to glabrate; seeds 0.75 cm. long, the tawny coma about 1 cm. long.

MEXICO: NUEVO LEON: between Monterey and Corralvo, May 28, 1847, *Wislizenus 341* (MBG); hills near Monterey, Aug. 31, 1903, *Pringle 11838* (C, FM, G, US);

PUEBLA: Tlacuiloltepec and Tres Mogotes, Aug., 1909, *Purpus 3989* (FM, G, MBG, NY, UC, US); HIDALGO: Sierra de la Mesa, Ixmiquilpan, July–Sept., 1905, *Purpus 1378* (FM, G, MBG, NY, UC); SAN LUIS POTOSI: Minas de San Rafael, May, 1911, *Purpus 5206* (FM, MBG, G, NY, UC, US); same locality, Nov., 1910, *Purpus 5055* (MBG, UC); DURANGO: Inde, alt. 2000 m., July, 1927, *Reko 5212* (US); TAMAULIPAS: Buena Vista Hda., June 18, 1919, *Wooton s. n.* (US); COAHUILA: Monclova, Aug. 23–31, 1880, *E. Palmer 807* (G, MBG, US); vicinity of Saltillo, July 25, 1905, *E. Palmer 702* (US).

Strikingly intermediate in morphology and distribution between *M. hypoleuca* and *M. Macrosiphon*, and suggesting a hybrid origin.

5. **Macrosiphonia Macrosiphon** (Torr.) A. A. Heller, Muhlenbergia 1: 2. 1900.

Echites Macrosiphon Torr. Bot. Mex. Bound. Surv. 158. *pl. 43.* 1859.

Macrosiphonia Berlandieri A. Gray, Syn. Fl. 2¹: 83. 1878; Hemsl. Biol. Centr.-Am. Bot. 2: 315. 1882; K. Sch. in Engl. & Prantl, Nat. Pflanzenfam. 4²: 168. 1895.

Erect or somewhat diffuse, suffrutescent herbs 1.5–3.0 dm. tall; stems densely tomentulose when young, eventually becoming glabrate; leaves opposite, petiolate, ovate-elliptic to suborbicular, apex rather abruptly obtuse or rounded, infrequently acute or somewhat retuse, mucronulate, base obtuse or rounded, 1.5–5.0 cm. long, 1.0–4.5 cm. broad, firmly membranaceous, either surface densely tomentulose; petioles 0.2–1.0 cm. long; inflorescence terminal, bearing a solitary, white, vespertine flower, the peduncle obsolete or essentially so; pedicels 0.2–0.5 cm. long; bracts linear to ovate-lanceolate, 0.3–0.6 cm. long; calyx-lobes lanceolate to ovate, acute to acuminate, 1–2 cm. long, 0.2–0.5 cm. broad, conspicuously foliaceous, densely tomentulose; corolla infundibuliform, densely puberulent-papillate without, the proper-tube 3.5–9.0 cm. long, about 0.15 cm. in diameter at the base, the throat narrowly conical to subtubular, 1.0–2.5 cm. long, about 0.5–0.75 cm in diameter at the orifice, the lobes obliquely obovate, 1.5–3.0 cm. long, widely spreading; follicles relatively slender, continuous, 10–15 cm. long, puberulent-papillate to glabrate; seeds 0.5 cm. long, the pale tawny coma about 1 cm. long.

UNITED STATES: TEXAS: ledges, high limestone hills, Lacey's Ranch, Kerr Co.,

June 2, 1916, *E. J. Palmer 10018* (MBG); dry hills, Upper Hondo, June, year lacking, *Reverchon 1378* (FM, MBG, NY, US); Comanche Springs, June, 1849, *Lindheimer 984* (C, FM, G, MBG, NY, UC, US); hills near Van Horn, July 9, 1900, *Eggert s. n.* (MBG); infrequent, slopes, Limpia Canyon, Presidio Co., Aug. 22, 1919, *Hanson 752* (G, MBG, NY, US); Pena Colorado, date lacking, *Havard s. n.* (FM, MBG, US); dry limestone hillsides, upper Seco Creek, Bandera Co., June 18, 1916, *E. J. Palmer 10243* (MBG); chaparral, first ridge east of Juniper Canyon, Chisos Mts., Brewster Co., alt. 5500 ft., July 15–18, 1921, *Ferris & Duncan 2939* (CA, MBG, NY); higher ridges, vicinity of Mt. Livermore, Davis Mts., Jeff Davis Co., July 9–12, 1921, *Ferris & Duncan 2520* (CA, MBG, NY, US); dry calcareous hills, Barksdale, Edwards Co., Oct. 11, 1916, *E. J. Palmer 10995* (MBG); Marathon, Aug., 1925, *Bogusch 946* (US); Marfa, June 3, 1926, *Orcutt 1218* (US); Glass Mts., Aug. 19, 1925, *Tharp 3646* (US); Ft. Pena Colorado, Aug., 1925, *Tharp 4648* (US); southern slopes of higher mountain-tops, 5 mi. west of Comanche Springs, June–Aug., 1849, *Lindheimer 128* (G, MBG); rocky slopes, Blue Creek Canyon, Brewster Co., alt. 1520 m., June 26, 1931, *Moore & Steyermark 3243* (MBG); data incomplete: May–Oct., 1849, *Wright 557* (FM, G, MBG, UC); *Berlandier 3197* (G, MBG, US).

MEXICO: CHIHUAHUA: Santa Eulalia Plains, June–Aug., 1885, *Wilkinson s. n.* (FM, UC, US); hills near Chihuahua, March–Oct., 1886, *Pringle 694* (FM, G, MBG, NY, US); DURANGO: from Ramon to Inde, Aug. 11–14, 1898, *Nelson 4692* (G, MBG, US).

Subgen. II. EUMACROSIPHONIA Woodson, n. subgen.

Flowers few to several, rarely solitary. Peduncle elongate, usually greatly surpassing the subtending leaves; pedicels relatively indistinct. Calyx somewhat foliaceous, immediately subtended by bracts. Suffrutescent herbs of southeastern Brazil and adjacent Paraguay, Uruguay, and Argentina. *Spp. 6–10.*

KEY TO THE SPECIES

a. Corolla-throat narrowly conical or subtubular.
  b. Leaves not concolorous, variously pubescent above, densely arachnoid-lanate beneath.
    c. Plants essentially erect; leaves strictly opposite, 3–7 cm. long.
      d. Inflorescence several-flowered; upper leaf-surface densely velutinous interspersed with long hairs....................*6. M. Martii*
      dd. Inflorescence 1-flowered; upper leaf-surface simply pilose or slightly as above....................*7. M. virescens*
    cc. Plants more or less decumbent; leaves verticillate or rarely opposite in individuals, 1.5–5.0 cm. long....................*8. M. petraea*
  bb. Leaves concolorous, either surface densely arachnoid-lanate....*9. M. Velame*
aa. Corolla-throat broadly conical to campanulate..............*10. M. longiflora*

6. Macrosiphonia Martii Muell.-Arg. in Mart. Fl. Bras. 6^1: 138. 1860; Miers, Apoc. So. Am. 130. 1878.

Echites virescens Stadelm. not St. Hil. ex Muell.-Arg. loc. cit. 139. 1860, nom. nud. in synon.

Erect or ascending, suffrutescent herbs 1.5–4.0 dm. tall; stems relatively stout, densely arachnoid-lanate; leaves opposite, shortly petiolate to subsessile, broadly oblong to oblong-elliptic, apex acute, base truncate to broadly and very obscurely cordate, 5–7 cm. long, 1.5–3.0 cm. broad, firmly membranaceous, above dark green, densely velutinous interspersed with long, weak hairs, beneath much paler, densely arachnoid-lanate; inflorescence terminal, 2–9-flowered, the peduncle 15–45 cm. long; pedicels 0.3–0.5 cm. long; calyx-lobes lanceolate, acuminate, 1.0–1.5 cm. long; corolla infundibuliform, finely arachnoid-lanate without, the proper-tube 4.5–6.0 cm. long, about 0.2 cm. in diameter at the base, the throat narrowly conical to subtubular, 1.75–2.25 cm. long, about 0.75 cm. in diameter at the orifice, the lobes obliquely obovate, shortly acuminate, 1.25–1.5 cm. long, widely spreading; follicles relatively stout, articulated, 12–15 cm. long, finely and sparsely arachnoid-lanate without; seeds 1.5 cm. long, the brilliant tawny coma about 2.5 cm. long.

BRAZIL: GOYAZ: campos, Mission of Duro, Febr. 10, 1839, *Gardner 3312* (B, BB, BM, K, NY, V, MBG, photograph); S. Luzia Megaponte, date lacking, *Pohl 970* (V); data incomplete: 1842, *Glaziou 21732* (Bx, C, K); *Gardner 3889* (B, BM, K, V); MINAS GERAES: Serra do Curral, prope Bello Horizonte, campo, March 23, 1929, *Ducke 21811* (B); Caete, Jan. 24, 1921, *Hoehne 5094* (B); in campis, Lagoa Santa, March, 1835, *Lund s. n.* (C); Lagoa Santa, Jan. 15, 1864, *Engle s. n.* (C); same locality, Jan. 25, March 2, Sept. 28, 1864, *Warming s. n.* (C); data incomplete: 1838, *Claussen 334* (G, NY); 1831, *Ackermann s. n.* (Bx); MATTO GROSSO: data incomplete, May 29, 1899, *Pilger 643* (B).

7. **Macrosiphonia virescens** (St. Hil.) Muell.-Arg. in Mart. Fl. Bras. 6^1: 139. 1860; Miers, Apoc. So. Am. 130. 1878.

Echites virescens St. Hil. Bull. Soc. Phil. 77. 1824; Mem. Mus. Paris **12**: 324. 1825; A. DC. in DC. Prodr. **8**: 472. 1844.

Macrosiphonia virescens (St. Hil.) Muell.-Arg. var. *Missionum* Chod. Bull. Soc. Bot. Genève II. **11**: 223. 1920.

Erect or ascending, suffrutescent herbs 1–3 dm. tall; stems relatively slender, fulvous-pilose when young, eventually becoming glabrate; leaves opposite, shortly petiolate, narrowly oblong-elliptic, acute, base abruptly rounded to obtuse, 3–7 cm. long, 1.0–1.5 cm. broad, firmly membranaceous, above dark green, pilose or pilosulose to glabrate, beneath much paler,

densely and minutely arachnoid-lanulose; petioles 0.2–0.3 cm. long; inflorescence terminal, 1- (rarely few-?) flowered, the peduncle 5–10 cm. long; calyx-lobes linear-lanceolate, long-acuminate, 1.75–2.5 cm. long, laxly pilosulose without; corolla infundibuliform, finely and rather sparsely arachnoid-lanulose without, the proper-tube 6.0–7.5 cm. long, about 0.2 cm. in diameter at the base, the throat narrowly conical to subtubular, 2.0–2.5 cm. long, about 0.75 cm. in diameter at the orifice, the lobes obliquely obovate, shortly acuminate, 1.75–2.0 cm. long, widely spreading; follicles relatively stout, articulated, 20–25 cm. long, sparsely arachnoid-lanulose to glabrate; seeds 1 cm. long, the brilliant tawny coma about 2.5 cm. long.

BRAZIL: SÃO PAULO: Cascaval, Dec. 1, 1920, *Gehrt 4652* (B); data incomplete: *Sello s. n.* (B); *Claussen 513* (DC); PARANA: in campo, Turma, alt. 800 m., Oct. 19, 1914, *Dusen 15653* (G, MBG).

ARGENTINA: MISIONES: San Ignacio, Oct. 30, 1892, *Niederlein 92* (B); same locality, Sept. 9, 1919, *Munies 94* (MBG); same locality, in campis siccis, date lacking, *Chodat & Vischer 205* (BB).

8. **Macrosiphonia petraea** (St. Hil.) K. Sch. in Engl. & Prantl, Nat. Pflanzenfam. 4²: 168. 1895.

Macrosiphonia verticillata Muell.-Arg. in Mart. Fl. Bras. 6¹: 140. 1860; Miers, Apoc. So. Am. 131. 1878.

More or less decumbent, suffrutescent herbs 0.5–3.0 dm. tall; stems relatively slender, fulvous-pilose or pilosulose when young, infrequently becoming glabrate when fully mature; leaves ternate or quaternate, infrequently opposite in individuals, sessile or subsessile, oblong-lanceolate to linear-filiform, rarely ovate-elliptic, acute to acuminate, base truncate or rounded, coriaceous to subcoriaceous, above dark green, usually nitidulous, simply pilose or pilosulose, beneath densely arachnoid-lanulose; inflorescence terminal or subterminal, 1–4-flowered, the peduncle 3–10 cm. long; calyx-lobes linear-lanceolate, long-acuminate, 1.5–2.5 cm. long; corolla infundibuliform, finely arachnoid-lanulose without, the proper-tube 6–8 cm. long, about 0.15 cm. in diameter at the base, the throat narrowly conical or subtubular, 2.0–2.5 cm. long, about 0.75 cm. in diameter at the orifice, the lobes obliquely obovate, shortly acuminate, 1.75–2.25 cm. long, widely spreading; follicles relatively slender, distantly articulated

or submoniliform, 15–25 cm. long, finely arachnoid-lanulose to glabrate; seeds about 1 cm. long, the brilliant-tawny coma about 2.25 cm. long.

Var. **typica.**

Echites petraea St. Hil. Mem. Mus. Paris **12**: 322. 1825; A. DC. in DC. Prodr. **8**: 472. 1844.

Macrosiphonia verticillata Muell.-Arg. *α. petraea* (St. Hil.) Muell.-Arg. in Mart. Fl. Bras. **6**[1]: 141. 1860.

Macrosiphonia verticillata Muell.-Arg. β. *intermedia* Muell.-Arg. loc. cit. 1860.

Stems 1–3 dm. tall; leaves oblong-lanceolate to oblong-elliptic, 1.5–5.0 cm. long, 1.75–2.5 cm. broad; inflorescence 1–4-flowered.

BRAZIL: RIO GRANDE DO SUL: São João, date lacking, *St. Hilaire 2597* (DL); Sta. Ana, May 26–28, 1907, *Herter 3128* (B).

PARAGUAY: in regione lacus Ypacaray, Jan., 1913, *Hassler 11477* (C, G, MBG); in campo, Nov., year lacking, *Hassler 3538* (B, G, MBG, NY, US); zwischen Rio Apa u. Rio Aquidaban, 1908–09, *Fiebrig 4545* (G).

ARGENTINA: CHACO: Las Breñas, alt. 250 m., Nov., 1929, *Venturi 9773* (MBG); CORDOBA: data incomplete, Jan. 16, 1902, *Stuckert s. n.* (UC); Nov. 19, 1880, *Galander s. n.* (NY); zw. Las Teñas u. Los Estadanos, gebiet des Rio Tercero, March 27, 1876, *Hieronymus s. n.* (B); FORMOSA: en el campo, April 8, 1919, *Jørgensen 3023* (FM, G); MISIONES: Posadas, in rupestribus ad Praed. "La Ganja," Nov. 12, 1907, *Ekman 1591* (MBG).

URUGUAY: Sta. Rosa, Dept. Artigas, Nov., 1927, *Herter 570* (NY); Concepcion, Nov., 1877, *Lorentz 1207* (B); Montevideo, date lacking, *Sellow 693* (V, MBG, photograph).

Var. **pinifolia** (St. Hil.) Woodson, comb. nov.

Echites pinifolia St. Hil. Mem. Mus. Paris **12**: 325. 1825; A. DC. in DC. Prodr. **8**: 471. 1844.

Echites grandiflora Desf. var. *minor* Hook. Jour. Bot. **1**: 286. 1834.

Echites Lambertiana Gillies, ex Hook. loc. cit. 1834, nom. nud. in synon.

Macrosiphonia verticillata Muell.-Arg. γ. *peduncularis* Muell.-Arg. in Mart. Fl. Bras. **6**[1]: 141. 1860.

Macrosiphonia verticillata Muell.-Arg. δ. *pinifolia* (St. Hil.) Muell.-Arg. loc. cit. 1860.

Macrosiphonia pinifolia (St. Hil.) Miers, Apoc. So. Am. 131. 1878.

Macrosiphonia prostrata Miers, loc. cit. 1878.

Echites multifolia Miers, loc. cit. 1878, nom. nud. in synon.

Macrosiphonia pinifolia (St. Hil.) Malme, Bull. Herb. Boiss. II. **4**: 257. 1904, sphalm.

Macrosiphonia pinifolia (St. Hil.) Malme var. *intermedia* (Muell.-Arg.) Malme, loc. cit. 1904.

Macrosiphonia Balansae Chod. Bull. Soc. Bot. Genève II. **11**: 224. 1920.

Macrosiphonia pinifolia (St. Hil.) Malme f. *glabrata* Chod. loc. cit. 225. 1920.

Macrosiphonia pinifolia (St. Hil.) Malme f. *setosa* Chod. loc. cit. 1920.

Macrosiphonia pinifolia (St. Hil.) Malme f. *peduncularis* (Muell.-Arg.) Malme, Arkiv f. Bot. **21A**^{6}: 14. 1927.

Macrosiphonia peduncularis (Muell.-Arg.) Hand.-Mzt. Denkschr. Akad. Wissensch. Wien **79**: 386. 1931.

Stems 0.5–2.0 dm. tall; leaves linear to filiform, 1.5–3.0 cm. long, 0.1–0.3 cm. broad; inflorescence 1-flowered.

Brazil: parana: Porto Amazonas, ad fl. Iguassu, alt. 735 m., Jan. 4, 1916, *Dusen 1090a* (MBG); same data, *Dusen 18056* (FM, G, NY); Ponta Grossa, in campo, alt. 880 m., Jan. 10, 1915, *Dusen s. n.* (G); data incomplete: *Widgren 578* (US); *Riedel s. n.* (G); *Lund s. n.* (C); *Sello s. n.* (B).

Paraguay: central Paraguay, 1888–90, *Morong 420A* (G, MBG, US); Santa Elisa, Gran Chaco, Dec., 1903, *Rojas 2654* (G, V); in viciniis Caaguazu, March, 1905, *Hassler 9081* (V).

Uruguay: Montevideo, date lacking, *Sello s. n.* (V); data incomplete: *Arechavaleta s. n.* (V).

9. **Macrosiphonia Velame** (St. Hil.) Muell.-Arg. in Mart. Fl. Bras. **6**^{1}: 138. *pl. 42.* 1860; Miers, Apoc. So. Am. 129. 1878; K. Sch. in Engl. & Prantl, Nat. Pflanzenfam. **4**^{2}: 168. 1895.

Echites Velame St. Hil. Bull. Soc. Phil. 77. 1824; Mem. Mus. Paris **12**: 324. 1825; Stadelm. Flora **24**^{1}: Beibl. 61. 1841; A. DC. in DC. Prodr. **8**: 471. 1844.

Macrosiphonia Velame (St. Hil.) Muell.-Arg. β. *goyazensis* Muell.-Arg. loc. cit. 1860.

Erect or ascending, suffrutescent herbs 1.5–4.5 dm. tall, densely arachnoid-lanate throughout; stems relatively stout; leaves opposite, very shortly petiolate to subsessile, broadly ovate- to oblong-elliptic, acute to obtuse, base rounded or truncate, 3–7 cm. long, 1.25–5.0 cm. broad, subcoriaceous, either

surface about uniformly pale; petioles 0.2–0.4 cm. long; inflorescence terminal, 3–8-flowered, the peduncle 3–8 cm. long; calyx-lobes linear-lanceolate, long-acuminate, 1.5–2.0 cm. long; corolla infundibuliform, densely arachnoid-lanate without, the proper-tube 7–8 cm. long, about 0.2 cm. in diameter at the base, the throat narrowly conical or subtubular, 1.5–2.0 cm. long, about 0.75 cm. in diameter at the orifice, the lobes obliquely obovate, 2.5–3.5 cm. long, widely spreading; follicles relatively stout, rather distantly articulated or moniliform, 15–25 cm. long, densely arachnoid-lanate to glabrate; seeds 1 cm. long, the brilliant-tawny coma about 2 cm. long.

BRAZIL: MINAS GERAES: in campis ad Lagoa Santa, Febr. 3, 1864, *Engle s. n.* (C); Lagoa Santa, March 28, 1864, *Warming s. n.* (C, NY, V); Ouro Branco, March 9, 1898, *Glaziou 15214* (BM, C); in campis, Caxoeira do Campo, Febr., 1835, *Lund s. n.* (C); same locality, 1840, *Claussen 172* (DL); Caldas, 1843, *Regnell 878* (B, Bx, C, FM, K, US); Poços de Caldas, Jan. 15, 1919, *Hoehne 2857* (B); Caraça, Febr., 1885, *Mendonça 506* (B); Chico Lobo, dans les champs, 1894–95, *Glaziou 21731* (B, Bx, C, K, NY); campo ad fl. S. Francisco, 1842, *Pohl s. n.* (Bx, V); Rio Campanero, Nov., 1883, *Dent s. n.* (BM); RIO DE JANEIRO: date lacking, *Glaziou 9507* (B); environs de Rio de Janeiro et d'Ouro Preto, 1883–84, *Glaziou 15215* (K); Serra da Pitangui, date lacking, *Sello 1664* (B); data incomplete, Aug.–April, 1840, *Claussen 1673* (K, MBG); *333* (C, NY); *336* (B); *711* (B); *108* (B); *511* (DC); July, 1916, *Porto 7931* (B); SÃO PAULO: steppe, norden des Staates S. Paulo, alt. 800 m., Oct., year lacking, *Peckholt 18* (B).

10. **Macrosiphonia longiflora** (Desf.) Muell.-Arg. in Mart. Fl. Bras. 6^1: 140. *pl. 43.* 1860; Miers, Apoc. So. Am. 130. 1878; K. Sch. in Engl. & Prantl, Nat. Pflanzenfam. 4^2: 168. *pl. 58, figs. m–n.* 1895.

Echites longiflora Desf. Mem. Mus. Paris **5**: 177. *pl. 20.* 1819; Stadelm. Flora 24^1: Beibl. 64. 1841; A. DC. in DC. Prodr. **8**: 471. 1844.

Echites Guarantica St. Hil. Bull. Soc. Phil. 77. 1824; Mem. Mus. Paris **12**: 324. 1825; A. DC. loc. cit. 472. 1844.

Echites augusta Vell. Fl. Flum. 114. 1830; Icon. **3**: *pl. 48.* 1827.

Echites grandiflora Desf. ex Hook. Jour. Bot. **1**: 286. 1834, sphalm.

Echites grandiflora Desf. var. *major* Hook. loc. cit. 1834.

Macrosiphonia Guarantica (St. Hil.) Muell.-Arg. loc. cit. 139. 1860; Miers, loc. cit. 129. 1878.

Macrosiphonia longiflora (Desf.) Muell.-Arg. var. *Guarantica* (St. Hil.) Malme, Bihang till K. Sv. Vet. Akad. Handl. Afd. III. **24**[10]: 18. 1899.

Erect or ascending, suffrutescent herbs 1.5–3.0 dm. tall; stems relatively stout, densely arachnoid-lanate; leaves opposite, subsessile to very shortly petiolate, ovate to ovate-elliptic, infrequently ovate-lanceolate, acute to acuminate, base rounded and rather broadly and obscurely cordate, 2–6 cm. long, 1–4 cm. broad, coriaceous, above dark green, sparsely arachnoid-lanulose when young, usually glabrate when fully mature, beneath much paler, persistently and densely arachnoid-lanate; inflorescence 1–3-flowered, the peduncle 6–20 cm. long; calyx-lobes linear-lanceolate, long-acuminate, 1.5–2.0 cm. long, densely arachnoid-lanate; corolla infundibuliform, densely arachnoid-lanulose without, the proper-tube 8–14 cm. long, about 0.3 cm. in diameter at the base, the throat broadly conical or campanulate, 2.0–2.5 cm. long, about 1.75–2.25 cm. in diameter at the orifice, the lobes obliquely obovate, indistinctly acuminate, 2.5–4.0 cm. long, widely spreading; follicles relatively stout, distinctly articulated or moniliform, 15–20 cm. long, sparsely arachnoid-lanulose to glabrate; seeds about 1 cm. long, the brilliant-tawny coma about 2 cm. long.

Brazil: bahia: Jacobina, date lacking, *Blanchet 3373* (FM, NY, V); Jacobina-Caceres, Oct., 1908, *Hoehne 335* (US); minas geraes: Lagoa Santa, Oct. 24, 1863, *Warming s. n.* (C); same locality, Nov., 1915, *Hoehne 6634* (B); Cachoeira, 1842, *Claussen 332* (C, G, V); S. Luzia, date lacking, *Pohl 895* (V); data incomplete: *Lund s. n.* (C); *Glaziou 21733* (C); *Widgren 582* (US); *Regnell 189* (US); são paulo: in campis, Nov., 1833, *Lund 886* (C); rio grande do sul: Sta. Ana, May 26–28, 1907, *Herter 3128* (B); parana: Jaguariahyva, in campo, alt. 740 m., Dec. 20, 1915, *Dusen 17456* (FM, G, MBG); same locality, Nov. 22, 1914, *Dusen 16031* (NY, US); same locality, Oct. 30, 1910, *Dusen 10676* (G, MBG); matto grosso: data incomplete, July, 1892, *Kuntze s. n.* (FM, NY); data incomplete: *Riedel s. n.* (NY, V, G); *Sellow 4500* (B, V).

Paraguay: in regione collium, Cordillera de Villa-Rica, Jan., 1905, *Hassler 8768* (G, V); same data, *Hassler 8825* (G, V); central Paraguay, 1888–90, *Morong 420* (NY, US); Cordillera de Altos, Nov. 7, 1902, *Fiebrig 387* (FM); same locality, Nov. 25, 1902, *Fiebrig 474* (FM); Centurion, zwischen Rio Apa u. Rio Aquidaban, Oct., 1909, *Fiebrig 4183* (G); in regione vicine Igatimi, Sept., year lacking, *Hassler 4724* (V); Cerro Pelado, Dec., 1929, *Jørgensen 3446* (MBG, US).

Also reported from northern Argentina.

(*To be continued*)

REPORT OF A BOTANICAL EXPEDITION INTO THE MOUNTAINS OF WESTERN TEXAS

JULIAN A. STEYERMARK

AND JOHN ADAM MOORE

Formerly Rufus J. Lackland Research Fellows in the Henry Shaw School of Botany of Washington University

Introduction

The mountainous country west of the Pecos has always challenged botanical collectors. The floras of many ranges are still totally unknown, although the collections of the pioneer botanists who passed through the region (Wright, Nealley, Schott, Bigelow, and Havard) have given us a fairly complete knowledge of the flora of the foothills and of a few of the mountain ranges. In the early part of this century, Baker, Earle and Tracy visited the Davis Mountains. Up to the time of her death, Dr. Mary S. Young was an enthusiastic student of this flora, visiting the Davis, Guadalupe, and Chisos ranges. The fact that these mountains constitute a meeting ground between the northern outposts of the typical Mexican flora and the southern relics of a northern Rocky Mountain flora has recently interested numerous botanists in the region.

We passed two months (June and July, 1931) in the region west of the Pecos, concentrating our collecting in the Davis, Chisos, and Guadalupe mountain ranges, as well as studying the flora of their foothills and the Rio Grande.

GENERAL GEOLOGY

In the United States the southernmost continuation of the Rocky Mountains is represented in western Texas by three ranges of mountains which stretch in a northwest-southeasterly direction in the region between the Pecos River and the Rio Grande. Northward all three of these ranges extend into New Mexico, and southward the two eastern ranges protrude into Mexico. The Rio Grande has cut a series of canyons through the two eastern ranges, a fact which suggests that the river was in existence before the mountains were uplifted across its course.

The westernmost range, the Franklin Mountains, is a continua-

Issued December 19, 1933.

tion of the Organ and San Andreas ranges of New Mexico, and ends a few miles north of El Paso.

The next range to the east enters Texas from the north as the Hueco Mountains on the west, and the Cornudas Mountains on the east. This broad dissected plateau, the Diablo Plateau, is separated from the Franklin Mountains by the low Hueco Basin. The plateau is surmounted by subsidiary mountains, one set of which is near the eastern margin and the other near the western. Beginning on the north with the Hueco Mountains and Cerro Alto, this western line of mountains continues southeasterly in the Finlay, Sierra Blanca, Malone, Quitman, Devil's Ridge, and Eagle Mountains. The eastern line comprises successively from north to south the Cornudas, Sierra Tinaja Pinta, Sierra Prieta, Sierra Diablo, Baylor, Carrizo, Van Horn, Tierra Vieja, Chinati, Cienaga, Sierra Bofecillos, and the Mesa de Anguila. It is through this last elevated portion that the Rio Grande has cut the Santa Helena Canyon, approximately 1800 feet in depth and only 50 feet across at the base in some places.

The easternmost range of Trans-Pecos Texas, at this latitude the front range of the Western Cordillera, enters Texas on the North as the Guadalupe Mountains, and continues successively southward as the Delaware, the Davis (Limpia or Apache), the Mount Ord, the Santiago, and the Sierra del Carmen. The latter continues into Mexico trenched by the deep narrow canyons of the Rio Grande.

There are other minor mountains east of the front range proper. Such are the Barilla, Sierra Madera, Glass, the Marathon Uplift, and a series of four long ridges cut through by the Rio Grande in deep canyons between the Sierra del Carmen and the mouth of San Francisco Creek. These are regarded as subsidiary arches and folds in Comanchean and earlier sedimentary rocks and in later lavas (in the Barilla Mountains). These folds gradually die out eastward as the intensity of the orogenic forces decreased in that direction.

Most of the mountains are of the broad, somewhat flat, plateau type. A few, such as the Guadalupes and Chisos, are very rugged and greatly dissected. Elevations in the Trans-Pecos Mountain region range from 1500 feet in the Rio Grande valley,

at the eastern base of the Sierra del Carmen, to about 9500 feet in Guadalupe Peak near the New Mexico line, the highest point in Texas. Although the majority of the Trans-Pecos mountains are composed of folded and faulted sedimentary strata, some include areas of igneous rocks. These igneous rocks have intruded through or bowed up the sedimentary strata, as in the Chisos Mountains, or they have formed great plateau areas of lava flows, as is found in the Davis Mountains.

This mountainous country was formed by the uplifts and foldings which occurred at or towards the close of the Pliocene, and consequently is geologically recent. A brief summary of the recent Cenozoic geological history will serve to bring out this point:

"At the end of the Eocene most of Texas became dry land and has remained dry land ever since. The only portion of Texas submerged beneath the waters of the Gulf since the close of the Eocene was a relatively narrow fringe along the present gulf border. All the Oligocene, Miocene, and Pliocene deposits of Texas are of non-marine origin in the region of their outcrops.

"Near or at the close of the Pliocene the mountains of New Mexico and Trans-Pecos Texas were again uplifted. In the Trans-Pecos mountain region the rocks were again folded and huge blocks of the earth surface were uplifted along lines of great dislocations or faults. The mountains of Trans-Pecos Texas as we see them today were formed at this time by these movements. Since then the mountains of New Mexico and Trans-Pecos Texas have been greatly eroded and debris from them was spread as a thin sheet of sands, gravels, and clays over nearly the whole of Texas. . . . Remnants of these deposits of sand and gravel, known as the Lafayette, are still found in all parts of Texas except on the surface of the Edwards Plateau and the summits and bedrock slopes of the Trans-Pecos Mountains. . . . All of the rivers of Texas, except the Rio Grande, the lower end of the Pecos, the Colorado, the Brazos, the Canadian, and possibly the Red, have cut their valleys since the Lafayette epoch. All the canyons in Texas, including . . . McKittrick canyon of the Guadalupe Mountains, Madera canyon of the Davis Mountains, the Santa Helena and other canyons of the Rio Grande, the canyon of the Pecos . . . have been cut since the beginning of the Lafayette epoch."[1]

The recent epoch is one of widespread erosion of Texas land and the materials are being transported to the Gulf by the rivers and there being deposited below the level of the tide.

Description of Regions Visited

Davis Mountains.—For an admirable description of the ligneous flora, geology, and general features of this region, the

[1] Udden, J. A., C. L. Baker, and E. Bose. A review of the geology of Texas. Univ. Tex. Bull. 44. 1916.

reader is referred to E. J. Palmer's account.[2] Since he had already collected in the highest portions of these mountains, we confined our collecting to the regions of lower elevation in and around Little Aguja and Big Aguja Canyons.

Study Butte Area.—This is a region of low elevation and low relief, of heavily gullied and terraced bare hills, gypsum flats, and occasional barren sand ridges eroded from the Cretaceous Terlingua Beds and Tornillo Clays. This area is situated about 10 miles southwest of the Chisos Mountains and about 10 miles north of the Rio Grande. Plants growing on the gypsum flats, such as *Suaeda suffrutescens, Atriplex canescens, A. acanthocarpa,* are calciphiles, as are most plants of the area.

Chisos Mountains.—The flora of the Chisos Mountains includes a far greater proportion of the Mexican element than does the Davis Mountains. Although there are many species such as *Heuchera rubescens, Rhamnus Purshiana, Pseudotsuga taxifolia, Amesia gigantea,* and *Aquilegia chrysantha,* which come from the north into the Chisos Mountains, the Mexican species which extend north into the region constitute an important element in the flora. Palmer (loc. cit.) gives an excellent account of the region.

Canyons of the Rio Grande.—At Boquillas, the river enters a deep canyon in the Edwards limestone. We collected in and about the head of the canyon on the American side. Further upstream the river has cut St. Helena Canyon, a narrow limestone gorge 7 miles long with almost vertical walls 1800 feet high. At the lower end, it was possible to proceed for collecting less than half a mile up the canyon.

Guadalupe Mountains.—These are a southern extension of the Sacramento Range. While most of the Guadalupes lie in New Mexico, the highest and the wettest portion of the range extends into Culberson Co., Texas. Guadalupe Peak (9500 ft.), the highest peak of the range, is the highest point in Texas. The ruggedness of the mountains results from the deep, steep-walled, narrow, tortuous canyons, incised in the thick Permian limestone of which the range is largely composed. Some of the canyons, McKittrick and Dog, contain sizeable permanent streams, and

[2] Palmer, E. J. Ligneous flora of the Davis Mountains. Jour. Arn. Arb. 10: 8–45. 1929.

support a mesophytic vegetation. In these cool moist canyons many northern species thrive. While a few Mexican species are found, such as *Selaginella Pringlei*, *Carex planostachys*, *Oryzopsis fimbriata*, the flora is dominated by Rocky Mountain species of more northern range. Some species are more common in the mountains of southern New Mexico and Arizona, and here make their eastern stand.

The Life Zones in the Guadalupe Mountains range from Lower Sonoran to Canadian. The characteristic vegetation of the Transition and Canadian Zones is found in the deep moist shaded canyons and on the high ridges and peaks. A few forms are endemic—*Tradescantia Wrightii*, *Sisyrinchium longipedunculatum*, *Laphamia quinqueflora*, *Valeriana texana*, *Polygala rimulicola*, *Festuca ligulata*.

For many things which contributed toward the success of our collecting trip, we thank Dr. George T. Moore, Director of the Missouri Botanical Garden; Dr. J. M. Greenman, Curator of the Herbarium of the Missouri Botanical Garden; Dr. B. C. Tharp, University of Texas; Mr. E. J. Palmer, Arnold Arboretum; Mr. Homer Wilson, Del Rio, Texas; Mr. M. McAlpine, Toyah, Texas. We acknowledge the hearty coöperation of the following specialists who determined many of our plants: Dr. A. S. Hitchcock, grasses; Dr. W. R. Maxon, ferns; Dr. A. W. Evans, hepatics; Prof. Oakes Ames, orchids; Mr. E. B. Bartram, mosses.

Sets of our "Plants of Texas" may be found in the herbaria at the following institutions (listed in order of size of set): Missouri Botanical Garden; Arnold Arboretum (ligneous plants only); Gray Herbarium; University of California; Academy of Natural Sciences of Philadelphia; University of Michigan; New York Botanical Garden; Stanford University; California Academy of Sciences; University of Minnesota; United States National Herbarium; Geo. E. Osterhout.

Notes on Species New or Rare in the Flora of Texas

Bryophyta

HEPATICAE

Riella americana **Howe and Underwood. Davis Mountains, 3081. From the only known station in the mountains, now probably destroyed.**

MUSCI

Venturiella sinensis (Vent.) C. M. Guadalupe Mountains, 3524. Found for the first time in North America, growing on the bark of *Acer grandidentatum* var. *brachypterum*, in the upper part of McKittrick Canyon. Previously known only from Japan, China, and Korea.

Pteridophyta

FILICALES

Cystopteris fragilis (L.) Bernh. Guadalupe Mountains, 3561. Moist crevices among shaded boulders in Devil's Canyon. A southern extension of the range of a northern species. The first collection from western Texas.

Notholaena Greggii (Mett.) Maxon. Boquillas Canyon, 3348. Our collection of this rare Mexican fern, from crevices of the high exposed bluffs near the west end of the canyon, is the first made in the United States.

LYCOPODIALES

Selaginella Pringlei Baker. Guadalupe Mountains, 3502. A Mexican species collected only twice previously in the United States. On moist limestone ledges, along stream, McKittrick Canyon.

Spermatophyta

GYMNOSPERMAE

Pinaceae

Cupressus arizonica Greene var. *bonita* Lemmon. Chisos Mountains, 3207. A small grove of trees in upper Boot Spring valley constitutes the farthest-east station for this species.

Juniperus flaccida Schlecht. Chisos Mountains, 3330. A Mexican tree known in the United States only from the Chisos. The pronounced weeping habit reminds one of *Thuja* or *Libocedrus*. At the heads of canyons and along streams in sheltered places.

ANGIOSPERMAE (DICOTYLEDONEAE)

Amarantaceae

Cladothrix lanuginosa Nutt. var. *carnosa* Steyermark, Ann. Mo. Bot. Gard. 19: 389. 1932. Study Butte, 3795.

Asclepiadaceae

Asclepias glaucescens HBK. Chisos Mountains, 3417. In sheltered rocky woods at head of Green Gulch. A species of Arizona, New Mexico, and Mexico, not previously reported from Texas.

Berberidaceae

Mahonia repens (Lindl.) Don. Guadalupe Mountains, 3481. A northern species found here previously by Havard and Bailey. On moist shaded wooded slopes in McKittrick Canyon, and on the slopes of the ridge above the canyon.

Betulaceae

Ostrya Baileyi Rose. Guadalupe Mountains, 3483. On the sheltered ridges above McKittrick Canyon, a small tree; in the canyon, a large tree. Known only from the Guadalupe and Chisos Mountains.

Boraginaceae

Lappula grisea Wooton & Standley. Guadalupe Mountains, 3583. Not previously collected in Texas. On moist shaded soil, McKittrick Canyon.

Lithospermum viride Greene. Guadalupe Mountains, 3648. A New Mexican species found for the first time in Texas. Limestone ledges along trail out of McKittrick Canyon.

Campanulaceae

Campanula rotundifolia L. Guadalupe Mountains, 3449. Common in moist shaded grassy places, McKittrick Canyon. A northern form reaching the southern limit of distribution in the Guadalupe, Chenate, Davis, and San Antonio ranges.

Caprifoliaceae

Lonicera arizonica Rehder. Guadalupe Mountains, 3478. Shaded woods about the summit of Guadalupe Peak. The first collection from Texas.

Symphoricarpos rotundifolius Gray. Guadalupe Mountains, 3671. A northern species previously collected by Havard; in woods about Guadalupe Peak.

Caryophyllaceae

Drymaria gracilis Cham. & Schlecht. Davis Mountains, 3044. The northern limit for a Mexican species. Large clumps in sheltered soil pockets at base of bluff in Little Aguja Canyon.

Compositae

Actinea Richardsonii (Hook.) Ktze var. *floribunda* Gray. Guadalupe Mountains, 3676. New to Texas flora. Scattered colonies in *Pinus ponderosa* woods on the limestone ridge between Pine Canyon and Guadalupe Peak. A species commoner in central and southern Rocky Mountains.

Aplopappus gymnocephalus DC. forma **albus** Steyermark and Moore, f. nov. Ligulis albis. Ridge above McKittrick Canyon, Guadalupe Mountains, Culberson Co. Texas, July 17, 1931. Moore & Steyermark 3488, TYPE in Herbarium of Missouri Botanical Garden. The ligules on all the heads were white, their color in the species being some shade of pale purple or pink. The species is commoner in the central Rocky Mountains and has been collected here by Havard.

Brickellia Coulteri Gray. Boquillas Canyon Region, 3438. A low slender subligneous plant, on steep rocky slopes at head of sand dunes at the mouth of the canyon. Our collection differs from typical *B. Coulteri* in having broader more obtuse involucral bracts.

Brickellia Fendleri Gray. Guadalupe Mountains, 3557. A northern species found for the first time in Texas. Moist shaded slopes in a ravine of Devil's Canyon, also in McKittrick Canyon.

Coreopsis lanceolata L. Guadalupe Mountains, 3632. This station on the high grassy ridges is the farthest-west record for the species in Texas.

Eupatorium Parryi Gray. Chisos Mountains, 3408. This rare Mexican species

was found in dry sheltered rocky woods growing in rich soil at the head of Cat Tail Canyon, close by the falls. Our collection, the second ever to be made, adds this plant to the United States flora.

Hieracium carneum Greene. Guadalupe Mountains, 3644. Open rocky slopes above McKittrick Canyon. A species of the southern Rockies of New Mexico and Arizona, previously collected in the Davis Mountains by Ferris & Duncan.

Hymenopappus radiatus Rose. Guadalupe Mountains, 3484. A species new to the flora of Texas, previously known from New Mexico and Arizona. On rocky open ground and in thickets of *Cercocarpus argenteus*, *Amelanchier florida* and *Robinia luxurians*, on the high ridge north of McKittrick Canyon.

Laphamia quinqueflora Steyermark, Ann. Mo. Bot. Gard. **19**: 392. 1932. Guadalupe Mountains, 3547.

Perityle Parryi Gray. St. Helena Canyon, 3466. Known previously in Texas by Havard's collection in the Bofecillos Mountains. In crevices at base of canyon walls.

Pinaropappus parvus Blake. Guadalupe Mountains, 3588. A rare suffruticose dwarf composite, forming large clumps in the shaded crevices of limestone cliffs. Found in the Texas Guadalupes by Standley and ourselves.

Solidago Wrightii Gray. Guadalupe Mountains, 3629. A rare species, this being only the second collection from Texas. At high altitudes on the ridges.

CRUCIFERAE

Sisymbrium diffusum Gray. Guadalupe Mountains, 3567. On limestone talus. Rare in these mountains; found previously in Texas in the Pena Colorado Mountains and Guadalupe Mountains by Havard, and by Wright on his El Paso expedition.

ERICACEAE

Arctostaphylos pungens HBK. Davis Mountains, 3145. A species of the mountains of Arizona, Nevada, and California, here recorded for the first time from Texas. On a rocky mesa and adjacent scrub oak slopes above Little Aguja Canyon, along with *Pinus cembroides* var. *edulis* and other shrubs.

EUPHORBIACEAE

Euphorbia eriantha Benth. Boquillas Canyon region, 3440. Rocky slopes at west end of Canyon. Rare, previously found in Texas by Hanson, at Redford.

FAGACEAE

Quercus hypoleuca Engelm. Davis Mountains, 3127. A rare oak, forming thickets about breast high on rocky slopes high above Little Aguja Canyon.

GENTIANACEAE

Frasera speciosa Dougl. Guadalupe Mountains, 3647. A northern plant known in Texas only from the Guadalupes. In open *Pinus flexilis* woods on high ridges.

GERANIACEAE

Geranium caespitosum James. Guadalupe Mountains, 3486. A northern plant reaching Texas only in the Guadalupes. On the high ridges in the open grassy *Pinus flexilis* forest. An oxylophile occurring with *Panicum bulbosum*.

Hydrophyllaceae

Nama Havardii Gray. Study Butte Area, 3248. On the gypsum flats associated with *Greggia camporum*. Other stations in the region are Hot Springs and the Tornillo Creek region.

Nama xylopodum (Wooton & Standley) C. Hitchcock. Guadalupe Mountains, 3562. Rock crevices and boulders along streams, McKittrick Canyon. Known in Texas only from the Guadalupe Mountains.

Leguminosae

Robinia luxurians (Dieck.) Rydb. Guadalupe Mountains, 3480. A northern tree known in Texas only from this range. On the high ridges, a shrub; in the canyons, a well-formed tree.

Linaceae

Linum Schiedeanum Cham. & Schlecht. Chisos Mountains, 3225. A Mexican species now reported as an addition to the United States flora. In sheltered woods at high elevations near Boot Spring.

Loasaceae

Mentzelia asperula Wooton & Standley. Guadalupe Mountains, 3679. A rare New Mexican species found for the first time in Texas. On dry limestone talus, ridge north of McKittrick Canyon.

Loganiaceae

Buddleia marrubifolia Benth. Boquillas Canyon Region, 3449. A Mexican species collected previously in the United States along the Rio Grande by Parry. In a small ravine north of Boquillas Canyon.

Loranthaceae

Arceuthobium vaginatum Eichler. Guadalupe Mountains, 3470. On *Pinus ponderosa*. A common species in the Rocky Mountains but found in Texas only in the Guadalupe and Davis ranges.

Monotropaceae

Hypopitys sanguinea Heller. Guadalupe Mountains, 3623. A northern species now reported for the first time from Texas. The entire plant is a deep scarlet-red and contrasts brilliantly with the leaf mould on which it grows. Shaded slopes in McKittrick Canyon.

Pterospora Andromeda Nutt. Guadalupe Mountains, 3642. On high ridges above McKittrick Canyon, in open *Pinus ponderosa* forest. A new record for Texas.

Nyctaginaceae

Boerhaavia erioselenus Gray. Boquillas Canyon Region, 3456. Known in Texas only in the vicinity of Tornillo Creek and near Hot Springs.

Polemoniaceae

Loeselia Greggii Wats. Chisos Mountains, 3344. Our collection from dry rocky sheltered draws, above Blue Creek Canyon, adds this Mexican species to our flora.

Polygalaceae

Polygala rimulicola Steyermark, Ann. Mo. Bot. Gard. 19: 390. 1932. Guadalupe Mountains, 3515. This endemic *Polygala* was so small that the specimens had to be dug out of the rock crevices with a penknife.

Polygonaceae

Eriogonum Havardii Wats. Guadalupe Mountains, 3609. Grass land on foothills below McKittrick Canyon; otherwise known in Texas from stations in the Chenate and Bofecillos Mountains, and at Langtry.

Eriogonum pannosum Wooton & Standley. Guadalupe Mountains, 3617. A rare species hitherto not reported from Texas. On the foothills below McKittrick Canyon.

Ranunculaceae

Aquilegia longissima Gray. Davis Mountains, 3104. The long-spurred columbine (spurs 6 inches long) has been found twice in Texas. Havard collected it in the upper ravines of the Chisos Mountains. Our station in the upper portion of Little Aguja Canyon, a shaded nook under a sheer bluff, is the second known from Texas.

Clematis alpina Mill. Guadalupe Mountains, 3670. A northern species known in Texas only from our collection near the summit of Guadalupe Peak.

Rhamnaceae

Rhamnus fasciculata Greene. Chisos Mountains, 3161. A species of New Mexico and Arizona found first in Texas by E. J. Palmer in the Davis Mountains; our station in the Chisos is the second for Texas.

Rosaceae

Eriogynia caespitosa Wats. Guadalupe Mountains, 3653. Shaded upper part of McKittrick Canyon, forming dense prostrate matted clumps. A rare species of higher latitudes, occurring in Texas only in the Guadalupe Range.

Holodiscus dumosus (Nutt.) Heller. Guadalupe Mountains, 3672. Our collection on the north-facing slopes of Guadalupe Peak links the northern distribution of the species with the outlying station found by E. J. Palmer on Mount Livermore in the Davis Mountains 100 miles to the southeast.

Prunus Havardii (Wight) Mason. Chisos Mountains, 3230. A rare shrub known formerly only from the collections of the Mexican Boundary Survey and of Havard from the Chisos Mountains. Our specimens were found at the head of Blue Creek Canyon. The gamosepalous calyces remain attached with the stamens to the fruit until maturity, and appear at first glance to be dried corollas.

Rosa mirifica Greene. Guadalupe Mountains, 3540. New to Texas flora, a rare species throughout the rest of its range. Along the stream, McKittrick Canyon.

Vauquelinia angustifolia Rydb. Chisos Mountains, 3203. A handsome shrub with the aspect of *Sorbus;* the flowers are fragrant. Known in the United States from this mountain range only. Gravelly banks, Oak Canyon and Blue Creek Canyon.

Saxifragaceae

Ribes mescalerium Coville. Guadalupe Mountains, 3669. Very rare outside type locality. On steep slopes below Guadalupe Peak.

Scrophulariaceae

Pentstemon baccharifolius Hook. Boquillas Canyon region, 3450. High limestone hills along Boquillas Canyon, the farthest-west station for this species in Texas, more common on the Edwards Plateau.

Valerianaceae

Valeriana texana Steyermark, Ann. Mo. Bot. Gard. 19: 393. 1932. Guadalupe Mountains, 3528.

Verbenaceae

Bouchea spathulata Torr. Boquillas Canyon region, 3446. Collected previously in Texas by Hanson and Havard. Rock ridge above canyon. The plants are suffruticose at the base, have thick coriaceous leaves, and bright purple corollas.

MONOCOTYLEDONEAE

Bromeliaceae

Tillandsia recurvata L. Chisos Mountains, 3198. Although the usual habitat of the plant is trees or telephone wires, it was found growing on smooth vertical cliff faces below Emory Peak.

Commelinaceae

Tradescantia Wrightii Rose & Bush. Guadalupe Mountains, 3578. This rare endemic has been previously collected by Havard, Wright, and by Standley. Our collection, the fourth ever to be made, was obtained from plants growing on rocky banks along the stream, McKittrick Canyon. The corolla is dark purple and the tuberous roots are long and slender.

Cyperaceae

Carex microdonta Torr. & Hook. Guadalupe Mountains, 3511. The first record for western Texas. Moist grassy places along the creek in McKittrick Canyon.

Carex eburnea Boott. Guadalupe Mountains, 3572. At base of moist shaded limestone bluffs in McKittrick Canyon. Our collection represents the farthest-west station for the species. The only other record in Texas of this eastern and northern type is a collection from Harriman, Texas, by Ruth (U. S. National Herbarium).

Gramineae

Festuca ligulata Swallen, Amer. Jour. Bot. 19: 436. 1932. Guadalupe Mountains, 3576.

Sorghastrum nutans (L.) Nash. Guadalupe Mountains, 3628. A new southwestern limit for this species. Sandstone outcrop on ridge above McKittrick Canyon.

Sphenopholis obtusata (Michx.) Scribn. Guadalupe Mountains, 3564. The farthest southwest for the species.

Liliaceae

Zygadenus elegans Pursh. Guadalupe Mountains, 3564. On moist shaded limestone cliffs along the stream in McKittrick Canyon. This is the first collection from Texas, a record extending the distribution of the death camas southeastward.

Orchidaceae

Amesia gigantea (Dougl.) A. Nels. & Macbride. In the Chisos Mountains at the head of Cat Tail Canyon, in rich leaf mould associated with a most virulent species of poison ivy, 3406. Along the stream in McKittrick Canyon, Guadalupe Mountains, 3568.

Spiranthes saltensis Ames. Chisos Mountains, 3214. Prof. Ames informs us that there are but two other collections of this orchid, both from central Mexico. Ours is the first to be taken in the United States.

Potamogetonaceae

Potamogeton clystocarpus Fernald. Davis Mountains, 3088. This new species, described by Professor Fernald from our collection, occurred in shallow rock pools along the stream in the upper portions of Little Aguja Canyon. We regret to learn from Dr. R. A. Studhalter that in September, 1932, the region was visited by a cloudburst which washed the canyon clean of aquatic vegetation.

Potamogeton diversifolius Raf. Chisos Mountains, 3186 and 3414. The usual form with floating leaves (3186) was found in the creek near Boot Spring, while the rarer submersed form (3414) was found in a still deep pool at the head of Cat Tail Canyon. The latter were slender nearly sterile plants about 20 inches tall. All the leaves were submersed and linear. This species was also found in the upper part of Little Aguja Canyon in the Davis Mountains.

Additional Records of Interest

The following is a list of plants for which we found new stations or which are rare in Texas. Our collection numbers are cited with each species mentioned. Abbreviations indicating the regions to which records refer, are as follows:—

(C) — Chisos Mountains.
(D) — Davis Mountains.
(G) — Guadalupe Mountains.
(S) — Study Butte Region.
(H) — St. Helena Canyon.
(B) — Boquillas Canyon.

Pteridophyta—Filicales

Bommeria hispida (Mett.) Underw. (D). 3042.

Cheilanthes castanea Maxon (C). 3191.

Cheilanthes Eatoni Baker (C, D). 3020, 3173.

Cheilanthes Fendleri Hook. (D). 3135.

Cheilanthes Wrightii Hook. (D). 3023.

Notholaena Standleyi Maxon (D). 3022.

Pellaea microphylla Mett. (C, G). 3370, 3514.

Pellaea Wrightiana Hook. (D). 3019.

Woodsia mexicana Fée (C). 3167.

Pteridophyta—Lycopodiales

Selaginella Sheldoni Maxon (D). 3047.

Spermatophyta

Gymnospermae—Pinaceae

Juniperus monosperma Sarg. (G). 3520.

Juniperus Pinchotii Sudw. (C, G). 3148, 3473.

Pinus flexilis James (G). 3469.

Angiospermae—Dicotyledoneae

Acanthaceae

Anisacanthus insignis Gray (C). 3202.

Ruellia Parryi Gray (H). 3459.

ASCLEPIADACEAE
Acerates auriculata Engelm. (G). 3553.
Asclepias macrotis Torr. (G). 3559.
Funastrum Torreyi (Gray) Schltr. (C). 3234.
Metastelma barbigerum Scheele (C). 3365.
Rouliniella unifaria (Scheele) Vail. (C). 3398.

BERBERIDACEAE
Mahonia haematocarpa (Wooton) Fedde (C). 3311.

BORAGINACEAE
Coldenia Greggii (T. & G.) Gray (B). 3452.
Heliotropium confertifolium Torr. (C). 3264.
Heliotropium convolvulaceum Gray (B). 3431.

CAPRIFOLIACEAE
Symphoricarpos longiflorus Gray (G). 3478.

CARYOPHYLLACEAE
Cerastium brachypodum (Engelm.) Robinson (C). 3168.
Paronychia Jamesii T. & G. (D, G). 3141, 3612.
Silene laciniata Cav. var. *Greggii* Wats. (C, G). 3190, 3646.

CELASTRACEAE
Mortonia scabrella Gray (G). 3665.

COMPOSITAE
Baccharis pteronioides DC. (C). 3346.
Berlandiera macrophylla (Gray) Jones (G). 3630.
Brickellia brachyphylla Gray (G). 3587.
Carpochaete Bigelovii Gray (C). 3201.
Chrysactinia mexicana Gray (C). 3170.
Chrysopsis fulcrata Greene (C, G). 3212, 3529.
Chrysopsis viscida Greene (D). 3071.
Heliopsis parvifolia Gray (C). 3213.
Lactuca ludoviciana DC. (C). 3393.
Laphamia rupestris Gray (D). 3041.
Perezia Wrightii Gray (C). 3337.
Stephanomeria tenuifolia (Torr.) Hall (G). 3534.

CONVOLVULACEAE
Dichondra brachypoda Woot. & Standl. (D, G). 3063, 3594.

CRASSULACEAE
Echeveria strictiforme Gray (C). 3336.
Sedum moranense HBK. (C). 3169.

CRUCIFERAE
Lesquerella purpurea Wats. (C). 3197.
Streptanthus platycarpus Gray (G). 3541.

EUPHORBIACEAE
Bernardia myricaefolia (Scheele) Wats. (C). 3289.
Ditaxis serrata (Torr.) Heller (H). 3464.
Euphorbia antisyphilitica Zucc. (B). 3443.
Euphorbia brachycera Engelm. (D, G). 3129, 3571.
Euphorbia cinerascens Engelm. (C). 3266.
Euphorbia Fendleri T. & G. var. *chaetocalyx* Boiss. (G). 3532.
Euphorbia heterophylla L. var. *graminifolia* Engelm. (G). 3531.
Euphorbia montana Engelm. (C). 3334.
Mozinnia sessiliflora (Hook.) Small (B). 3437.

FUMARIACEAE
Corydalis euchlamydea (Woot. & Standl.) Fedde (D, G). 3065, 3664.

LABIATAE
Brittonastrum neomexicanum Briq. (G). 3556.
Hedeoma mollis Torr. (C). 3409.

Hedeoma plicata Torr. (C, D). 3089, 3423.
Hedeoma thymoides Gray (B). 3445.
Salvia regla Cav. (C). 3179.
Scutellaria Drummondii Benth. (C). 3231.
Stachys Drummondii Benth. (D). 3099.

LEGUMINOSAE
Acacia cuspidata Schlecht. (C). 3338.
Cologania angustifolia Kunth (C). 3163.
Lotus Wrightii (Gray) Greene (C, D). 3143, 3224.
Parosela Jamesii (Torr.) Vail. (C). 3354.
Parosela mollis (Benth.) Heller var. *neomexicana* (Gray) Heller (C). 3270.

LINACEAE
Linum australe Heller (G). 3600.

LOASACEAE
Cevallia sinuata Lag. (C). 3253.
Eucnide bartonioides Zucc. (B). 3791.

LORANTHACEAE
Phoradendron Coryae Trel. (C). 3331.
Phoradendron Havardianum Trel. (G). 3608.

MALPIGHIACEAE
Janusia gracilis Gray (C). 3358.

MALVACEAE
Sphaeralcea Fendleri Gray (G). 3599.
Sphaeralcea incana Torr. (G). 3789.

MENISPERMACEAE
Cocculus carolinus DC. (C). 3401.

NYCTAGINACEAE
Allionia melanotricha Standl. (C). 3342.
Allionia pratensis Standl. (C). 3180.
Selinocarpus angustifolius Torr. (S). 3307.

OLEACEAE
Fraxinus Standleyi Rehder var. *lasia* Rehder (G). 3474.
Menodora decemfida (Gill.) Gray var. *longifolia* Steyermark (C). 3257.
Menodora scabra Gray var. *ramosissima* Steyermark (C). 3256.

ONAGRACEAE
Epilobium glandulosum Lehm. var. *adenocaulon* (Haussk.) Fernald (D). 3049.
Oenothera brachycarpa Gray var. *Wrightii* (Gray) Lévl. (G). 3554.

POLEMONIACEAE
Gilia incisa Benth. (C). 3315.
Gilia longiflora (Torr.) Don (S). 3305.

POLYGALACEAE
Polygala hemipterocarpa Gray (D). 3140.
Polygala macradenia Gray (C). 3274.
Polygala obscura Benth. (C). 3361.
Polygala puberula Gray (C). 3177.
Polygala scoparioides Chod. (C). 3251, 3273.
Polygala Tweedyi Britton (C). 3276.

PORTULACACEAE
Talinum brevifolium Torr. (G). 3677.

RANUNCULACEAE
Aquilegia Chaplinei Standley (G). 3549.
Aquilegia chrysantha Gray (C). 3405.
Thalictrum Fendleri Engelm. (G). 3566.

RHAMNACEAE
Ceanothus Greggii Gray (G). 3475.

ROSACEAE
Amelanchier florida Lindl. (G). 3482.

Cercocarpus argenteus Rydb. (G). 3489.

Cowania ericaefolia Torr. (B). 3451.

Physocarpus monogynus (Torr.) Coulter (G). 3666, 3673.

RUBIACEAE

Galium mexicanum HBK. (C). 3159.

Galium pilosum Ait. (C). 3162.

Galium Rothrockii Gray (C). 3322.

Houstonia fasciculata Gray (C). 3323.

RUTACEAE

Astrophyllum dumosum Torr. (G). 3552.

Ptelea monticola Greene (G). 3603.

Ptelea polyadenia Greene (C). 3184.

SALICACEAE

Salix taxifolia HBK. (D). 3125.

SAXIFRAGACEAE

Fendlerella utahensis (Wats.) Heller (G). 3626.

Heuchera rubescens Torr. (C, G). 3185, 3584.

Philadelphus serpyllifolius Gray (G). 3584.

SCROPHULARIACEAE

Mimulus glabratus HBK. var. *Fremontii* (Benth.) Grant (D). 3053.

Pentstemon dasyphyllus Gray (C). 3360.

Pentstemon Torreyi Benth. (C, G). 3313, 3631.

SOLANACEAE

Physalis hederaefolia Gray (H). 3462.

Physalis subintegra Fernald (C). 3195.

ULMACEAE

Celtis Douglasii Torr. (G). 3526.

UMBELLIFERAE

Pseudocymopterus montanus (Nutt.) C. & R. (D, G). 3131, 3136, 3573.

VERBENACEAE

Verbena perennis Wooton (G). 3611.

Verbena plicata Greene (S). 3299.

VITACEAE

Vitis arizonica Engelm. var. *glabra* Munson (G). 3527.

COMMELINACEAE

Setcreasea brevifolia (Rose) K. Schum. & Sydow (C, D). 3013, 3228.

CYPERACEAE

Carex hystericina Muhl. var. *Cooleyi* Dewey (G). 3503.

Carex planostachys Kunze (C). 3165.

Eleocharis arenicola Torr. (G). 3508.

Eleocharis caribaea (Rottb.) Blake (B). 3453.

Eleocharis mamillata Lindl. f. (G). 3505.

Mariscus jamaicensis (Crantz) Britton (G). 3679.

GRAMINEAE

Andropogon furcatus Muhl. (G). 3637.

Aristida glauca (Nees) Walp. (G). 3533.

Cathestecum erectum Vasey & Hack. (S). 3300.

Festuca ligulata Swallen (G). 3576.

Koeleria cristata (L.) Pers. (C, G). 3171, 3634.

Manisuris fasciculata (Lam.) Hitchc. (S). 3434.

Muhlenbergia pauciflora Buckl. (G). 3577, 3627.

Muhlenbergia polycaulis Scribn. (C). 3215.

Oryzopsis fimbriata (HBK.) Hemsl. (C, G). 3172, 3605.

Panicum bulbosum HBK. (C, G). 3371, 3633.

Sitanion hystrix (Nutt.) J. G. Smith (G). 3635.

Triodia avenacea HBK. (C). 3314, 3367.

Juncaceae

Juncus acuminatus Michx. (D). 3073.

Juncus nodosus L. (C). 3390.

Juncus Torreyi Coville (G). 3504.

Liliaceae

Allium cernuum Roth (G). 3537.

Allium stellatum Fraser (G). 3651.

Allium reticulatum Fraser (G). 3674.

Schoenocaulon Drummondii Gray (G). 3485.

Orchidaceae

Hexalectris spicata (Walt.) Barnh. (C). 3391.

Typhaceae

Typha domingensis Pers. (B). 3455.

LICHENS

Dermatocarpaceae

Dermatocarpon Moulinsii (Mont.) Zahlbr. (C).

Collemaceae

Collema plicatile Ach. (C).

Leptogium saturninum (Dicks.) Nyl. (G).

Lecideaceae

Lecidea crenata (Tayl.) Stzbgr. var. *coroniformis* (Krmphbr.) Zahlbr. (C).

Lecidea decipiens (Ehrh.) Ach. (C.)

Lecidea globifera Ach. (C).

Lecanoraceae

Lecanora pallida (Schreb.) Schaer. var. *angulosa* (Schreb.) Koerb. (G).

Parmeliaceae

Parmelia furfuracea (L.) Ach. (D, G).

Parmelia olivacea (L.) Nyl. (D).

Thelochistaceae

Xanthoria parietina (L.) Th. Fr. (C).

Buelliaceae

Rinodina oreina (Ach.) Wain. (C).

Physciaceae

Physcia stellaris (L.) Nyl. (C).

BRYOPHYTA

Hepaticae

Fossombronia brasiliensis Steph. (C). 3372.

Frullania inflata Gottsche (G). 3523.

Frullania riparia Hampe (G). 3497.

Plagiochasma Wrightii Sulliv. (C, D, G). 3033.

Porella platyphylloidea (Schwein.) Lindl. (G). 3496.

Musci

Amblystegium varium (Hedw.) Lindb. (D). 3091.

Anomodon minor (Palis.) Fuern. (G). 3654.

Coscinodon Wrightii (Aust.) Sulliv. (G). 3519.

Fabronia octoblepharis (Schleich.) Schwaegr. (C). 3294.

Funaria hygrometrica Hedw. (C). 3164.

Hedwigia albicans (Web.) Lindb. (C). 3174.

Homomallium mexicanum Card. (C, G). 3183, 3348, 3495.

Hymenostylium curvirostre (Brid.) Lindb. (G). 3582.

Hypnum revolutum (Mitt.) Lindb. (G). 3678.

Leptodictyum riparium (Hedw.) Warnst. (D). 3078.

Leptodictyum riparium f. *longifolium* Schultz (G). 3539.

Ptychomitrium serratum Schp. (G). 3796.

Tortella caespitosa (Schwaegr.) Limpr. (C). 3347.

Tortula obtusissima (C. M.) Mitt. (C). 3349.

GENERAL INDEX TO VOLUME XX

New scientific names of plants and the final members of new combinations are printed in **bold face** type; synonyms and page numbers having reference to figures and plates, in *italics;* and previously published scientific names and all other matter, in ordinary type.

A

B

F

G

L

M